Ontario Geological Survey
Mineral Deposits Circular MDC 15

CLAY AND SH. E DEPOSITS OF ONTARIO

by

G.R.Guillet

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197 *Not for resale*

Ontario

Ministry of Natural Resources

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GEOLOGICAL MAP
(back pocket)

Map 2358 (coloured) — Clay and Shale Deposits of Ontario
Scale 1:2,000,000.

ABSTRACT

Ontario clays and shales have been in use for more than a century in the making of bricks, tiles, and sewerpipes. This report describes some clay and shale occurrences not presently in commercial use. Data is presented on the geology, location, mineral and chemical composition, and ceramic properties of 45 shale samples, representing most of the shale formations of Ontario, and 162 clay samples from scattered locations throughout the province.

The analytical results from this testing program should be of particular interest to manufacturers of heavy clay products. Unfortunately, the clays and shales of Ontario are generally more calcareous than is desirable, and hence they are poorly suited to higher-quality applications such as stoneware, whiteware, refractories, and art pottery.

The heavy clay products industry is concentrated in the Central Ontario Region where the best-quality shales are located. Undeveloped deposits in this region may be unavailable for commercial development because of increased social pressures and competition for land use.

CLAY AND SHALE DEPOSITS OF ONTARIO

by

G. R. Guillet*

INTRODUCTION

This report is a companion volume to a previous one, The Clay Products Industry of Ontario, published in 1967 (ODM Industrial Mineral Report 22, Guillet, 1967). Whereas the previous volume described the operations of the brick, tile, and sewer pipe producers in Ontario, and detailed the geological and analytical properties of their shales and clays, the present report deals with clay and shale deposits not currently in use.

This report should be considered a sampling of clays and shales in Ontario, not an exhaustive report on the total potential of the province. As such it should be used along with a number of previous studies on the same subject, notably:

1) Clay and the Clay Industry of Ontario; by M.B. Baker, 1906.
2) Preliminary Report on the Clay and Shale Deposits of Ontario; by Joseph Keele, 1924.
3) The Ceramic Industry of Ontario; by R.J. Montgomery, 1930.
4) Ceramic Clays and Shales of Ontario; by J.G. Brady and R.S. Dean, 1966.
5) The Clay Products Industry of Ontario; by G.R. Guillet, 1967.

The report by Keele (1924) is particularly comprehensive, presenting chemical and ceramic data for a great many occurrences throughout the province. Baker (1906), Montgomery (1930), Brady and Dean (1966), and Guillet (1967) concentrate their studies on the clays and shales in use at their particular times. The present report is perhaps most similar to the one by Keele (1924). A short summary of clays and shales, and their ceramic properties, is also available (Guillet 1964).

A thorough investigation of the suitability of Ontario clays and shales for making lightweight aggregate has been reported on by H.S. Wilson (1963). Potential Clay and Shale Resources of Central Ontario were discussed by Vos (1975).

For anyone seeking new deposits, particularly clay deposits, the report entitled The Physiography of Southern Ontario, by L.J. Chapman and D.F. Putnam (1951, and subsequent editions) is invaluable. One should also ascertain the availability of maps and reports on the surficial or Pleistocene geology of specific areas of interest.

Clays and shales have been the traditional raw materials used in the making of bricks, drain and structural tiles, and sewer pipes for more than a century in Ontario. While this report is directed primarily to an evaluation of deposits for these uses, the analytical data are useful in other areas of research. Few of the clays in Ontario are suited to the making of art pottery, although some have been blended with higher quality imported clays for this purpose.

The heavy clay products industry has undergone much change during more than a century of existence. Initially characterized by a profusion of small labour-intensive plants using clay, the industry is dominated today by a few large highly-automated plants using shale almost exclusively. Relatively few plants producing drain tile continue to use clay. The total value of clay products produced in Ontario in 1974 was $37,810,000 (ODM Statistics Section).

Clays have several unusual properties that make them suited to the brick and tile-making process. These are the properties of plasticity and vitrification. Shales generally enjoy the same properties when they have been finely ground.

*Vice-President, Gartner Lee Associates Limited. Manuscript approved for publication by the Chief, Mineral Deposits Section, May 21, 1975.

Plasticity is developed in dry clays and ground shales through the addition of water in sufficient amount to permit working of the mass into any desired shape. Sufficient water is important to give easy workability and cohesion; too much water is indicated when the mass will no longer retain a desired shape.

Vitrification is the condition of partial fusion brought on by heat. It is a condition whereby a glassy bond is formed around unfused particles, resulting in greater density and hardness, and decreased porosity. Vitrification is accomplished by the firing of a moulded and dried clay body in a suitable furnace or kiln to a high temperature at a carefully controlled heating rate. The heating schedule is measured in terms of pyrometric cones, a convenient method for relating temperature and time to a single unit of measure. A further explanation of pyrometric cones is given by Guillet (1967, p.20).

The behaviour of clays and shales in the shaping and firing process is very much dependent on their physical (especially particle size), mineralogical (especially the relative proportions of clay minerals to non-clay minerals), and chemical (especially the ratio of lime to iron) properties. Clays of low-lime composition achieve a greater degree of vitrification, and a red colour due to oxidation of iron. Limy clays may fail to vitrify at all, but rather tend to expand and become less dense and more porous, and assume a yellow or buff fired colour. Because of the prevalence of limestones in Ontario's lowlands, many clays derived from them are limy.

Samples of clay and shale obtained for testing were analysed chemically and mineralogically. Hand moulded briquettes were tested at three different firing schedules: cones 010, 06 and 03, approximately equivalent to finishing temperatures of 1660°F (904°C), 1840°F (1004°C), and 1980°F (1080°C) respectively. Various properties significant in the ceramic evaluation of clays and shales were measured on the briquettes before and after firing, notably:

Plasticity
Drying shrinkage
Pyrometric cone equivalent (P.C.E.)
Firing shrinkage
Water absorption
Specific gravity
Colour
Hardness

A detailed account of clay properties and the testing procedures is given by Guillet (1967, p.18-30).

Field work for this report was carried out during the summer seasons of 1962 and 1963. A few additional samples were taken in 1965. Samples were normally channeled vertically from bank exposures. About 5 pounds of material were necessary in each case for the complete analytical program.

While the delay in publication of this data is regretable, it is significant that the relevance of the data does not diminish with time. Nevertheless, spreading urbanization and increased social pressures against pit and quarry operations have effectively eliminated some of the deposits from potential commercial utilization.

ACKNOWLEDGMENTS

The writer is particularly indebted to the staff of the Mineral Research Branch, Ontario Division of Mines, for all the laboratory work. A few clay samples were submitted by other staff members, of the Ontario Division of Mines and by members of the public. These persons are individually mentioned along with the descriptions of their samples.

GENERAL GEOLOGY OF ONTARIO SHALES

The major geological regions of Ontario are illustrated in Figure 1. There are two principal elements: The Precambrian Shield, and the Phanerozoic Lowlands. The Shield area occupies the central portion of the province and is characterized by a variety of ancient metamorphosed igneous and sedimentary rocks of Precambrian age. Phanerozoic Lowlands occupy the southern and northern fringes of the province and consist of relatively young and unmetamorphosed sedimentary rocks. The term "Phanerozoic" includes all rock strata younger than the Precambrian, including Paleozoic strata and glacial drift of the Pleistocene Epoch.

Paleozoic rocks of the southern lowlands are the most important sources of shale for heavy clay products. These rocks are divided geographically into two parts by the Precambrian rocks of the Frontenac Axis that extend

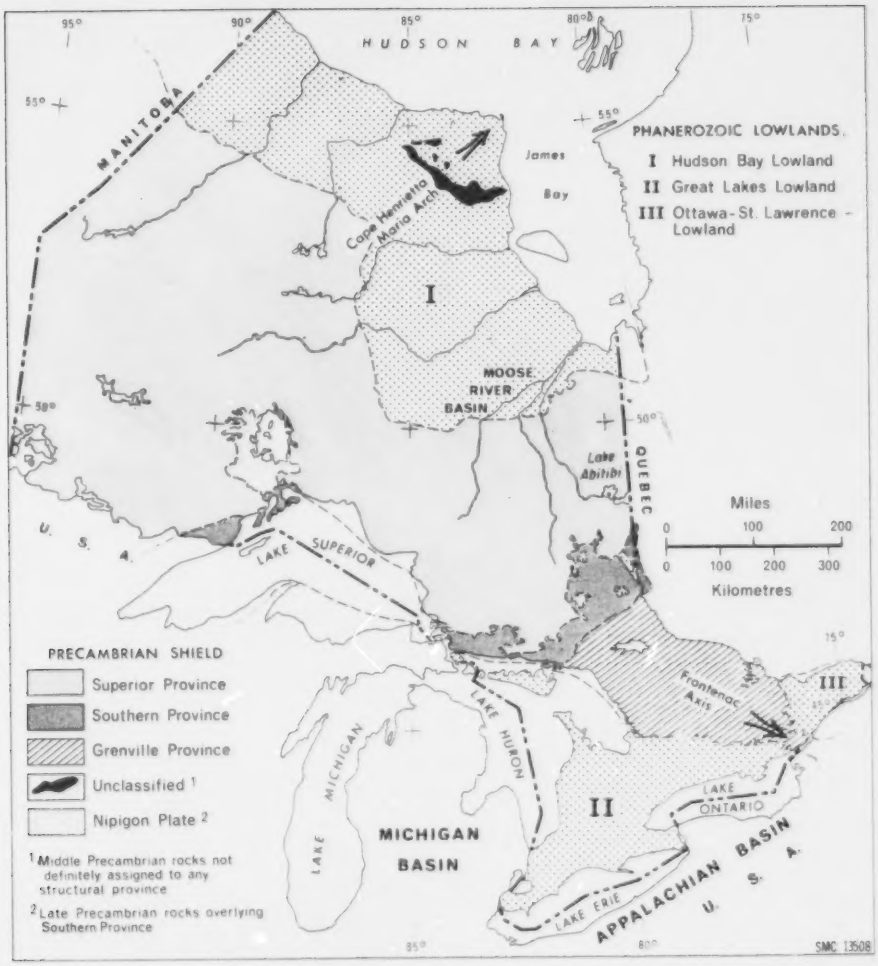


Figure 1 – Geological regions of Ontario.

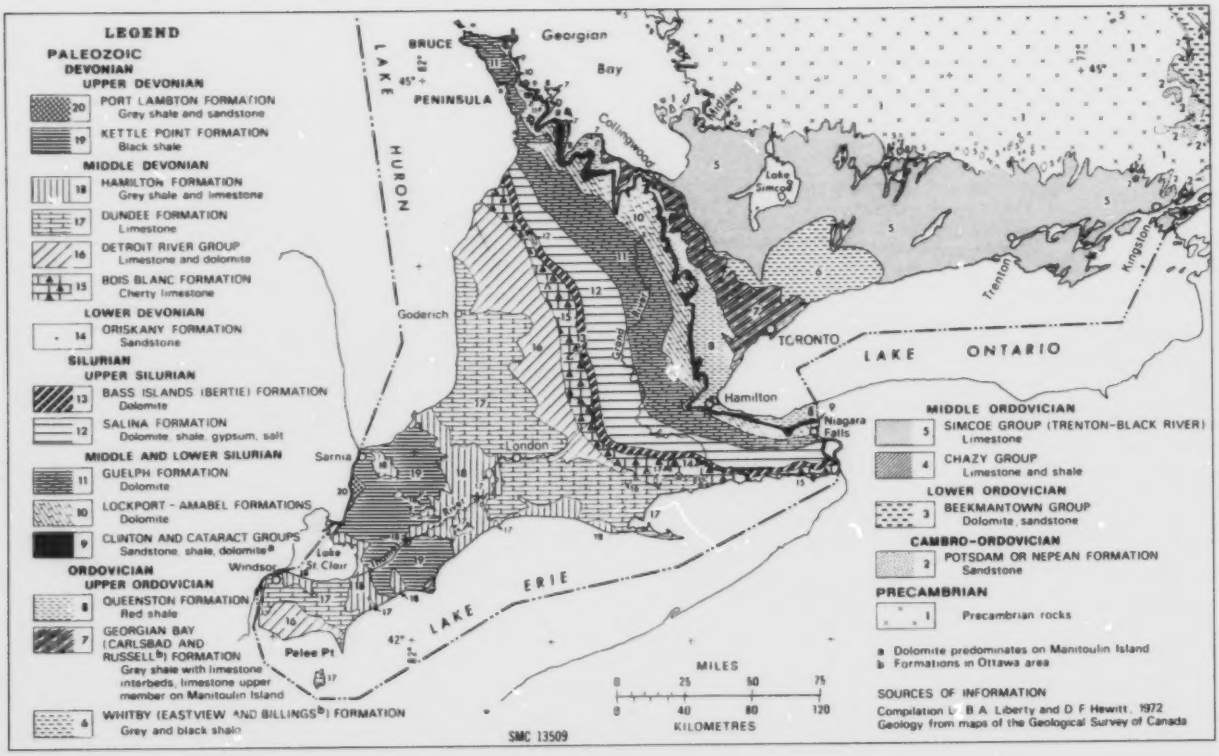


Figure 2 – Geology of the Great Lakes Lowland in Ontario.

TABLE 1 SUCCESSION OF SHALE FORMATIONS IN ONTARIO.

SYSTEM	FORMATION	LITHOLOGY	OTHER NAMES OR RELATED ROCKS
Devonian	Port Lambton	Grey to black shale, sandstone, siltstone.	
	Kettle Point	Brittle black shale.	Huron
	Hamilton	Grey shale and argillaceous limestone.	
	Marcellus	Black bituminous shale.	
Silurian	Salina	Dolomite, shale, salt, gypsum.	Camillus
	Clinton Group:		
	Rochester	Grey calcareous shale.	
	Neagha	Grey-green shale and limestone.	
	Wingfield	Green-grey shale and dolomite.	
	Cataract Group:		
	Cabot Head	Soft grey and red shale.	Grimsby, Power, Glen, Thorold, Medina
Ordovician	Queenston	Red shale.	Medina
	Georgian Bay	Grey shale, minor limestone and sandstone.	Dundas, Meaford, Lorraine, Hudson River, Richmond, Wekwemikongsing, Carlsbad, Russell
	Whitby	Blue, brown, black shale.	Blue Mountain, Sheguiandah, Utica, Collingwood, Billings, Gloucester, Eastview, Rouge River, Craigleith
	Rockcliffe	Grey-green shale and sandstone.	
	Shadow Lake	Red and green clastic sediments.	
Precambrian			
	Animikie Group:		
	Rove	Brittle grey black shale.	

TABLE 2 ANALYTICAL DATA — SHADOW LAKE SHALE.

SAMPLE DESCRIPTION:

63-430: Highway 35 roadcut, 4 miles (6 km) north of Coboconk; 4 foot (1.2 m) section of red arkose and interlayered green shale.

PARTIAL CHEMICAL ANALYSIS:

Sample 63-430	Percent
Fe_2O_3	2.00
CaO	25.60
Soluble salts	0.68
Ignition loss	35.08

MINERAL ANALYSIS:

Sample 63-430	Percent
Non-clay minerals:	
Quartz	6.0
Calcite	6.0
Dolomite	59.0
Soda-lime feldspar	0.5
Potash feldspar	4.0
Clay minerals:	
Illite	B
Chlorite	C

(B = moderate; C = minor)

CERAMIC PROPERTIES:

						Fired Characteristics					
						% water Absorption					
Sample	% Water of plasticity	% Drying shrinkage	PCE	Cone*	% Firing Expansion	24-hr. cold	5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
63-430	20	3.2	14-15	010	2.2				Olive-grey	Very soft	Fired briquettes are
				06	5.5	55.0	65.6	1.05	Olive-green	Very soft	soft, chalky, and
				03	5.3	53.5	65.8	1.05	Olive-green	Very soft	weak.

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), cone 06 (1840°F), cone 03 (1980°F).

southward into New York State between Gananoque and Brockville.

West of the Axis a sequence of Cambrian to Devonian rocks dips gently to the southwest and comprises the Great Lakes Lowland (Figure 2). Shales of the Queenston and Georgian Bay Formations of Ordovician age outcrop in the Toronto and Hamilton area, and are the principal raw materials for building bricks in the province. Descriptions of these and a number of other shales in the Great Lakes Lowland form a major part of this report.

A smaller portion of the Paleozoic record is represented by Cambrian and Ordovician rocks that make up the Ottawa-St. Lawrence Lowland east of the Frontenac Axis. A limited occurrence of shales comparable to the Queenston and Georgian Bay Formations of the Great Lakes region is present in the Ottawa area.

The Hudson Bay Lowland is underlain by Paleozoic rocks similar to those of the southern lowlands. In addition, a limited occurrence of Cretaceous strata of Mesozoic age is present in the Moose River Basin beneath a thick mantle of glacial materials. Cretaceous kaolin, fireclay, quartz sand, and lignite have been briefly described previously (Guillet 1964) and are mentioned in a number of earlier geological reports, particularly those of the Ontario Department of Mines. Neither the Cretaceous materials nor the Paleozoic shales of the Hudson Bay Lowland are described in this report. At least in some cases the properties of the shales are likely to be similar to their counterparts in southern Ontario but suitable exposures are few and difficult of access.

In addition to the three major lowland regions Paleozoic shales are also present on Manitoulin Island (which is really a part of the Great Lakes Lowland) and in the Timiskaming outlier at New Liskeard. Precambrian shales of the Animikie Group are widespread in the Thunder Bay area.

Ontario shales have not been characterized by a consistent nomenclature. While this report uses nomenclature that is in current use, it is recognized that some of the names may be unfamiliar. Table 1 lists the shale formations of Ontario and indicates other names that are or have been applied to the same or similar strata.

Detailed descriptions of Ontario shales are contained in the following pages.

SHALE RESOURCES

Central and Southwestern Ontario

SHADOW LAKE SHALE

Minor shale occurs with arkose and grit to form the lowest unit of the Ordovician section in southern Ontario. The thin discontinuous red and green clastic rocks of the Shadow Lake Formation are found in outcrop at the Precambrian contact north of Lindsay and Peterborough, and above Cambrian sandstones in the Gananoque area. The rocks are compositionally variable, and quite unsuitable for clay products.

Geology

The Shadow Lake Formation consists of red and green clastic sediments of limy, sandy and shaly character. The formation is 0-12 m (0-40 feet) thick, and underlies grey and brown limestones of the Simcoe Group.

Composition

Rocks of the Shadow Lake Formation are soft, unconsolidated, and dolomitic. Total carbonate content of a sample taken near Coboconk was more than two-thirds of the total. Illite is present in moderate amount. Chemical and mineral analyses are given in Table 2.

Ceramic Properties and Utilization

Shadow Lake rocks were sampled at only one spot, near Coboconk, where they were found to be quite unsuitable for ceramic uses. The sample was limy and gritty, and of low plasticity and strength. It expanded on firing, giving a very soft and highly absorptive olive-green body. Complete results of ceramic testing are shown in Table 2.

Distribution and Occurrences

The Shadow Lake Formation outcrops sporadically in the Lake Simcoe and Kawartha Lakes area. It is best seen at the following localities: at Waubaushene; 0.8 km (½ mile) north of Sebright; on the northwest shore of Head Lake; 6 km (4 miles) north of Coboconk (Liberty 1969, p.16). The Coboconk exposure is described in the following note.

Coboconk

Six kilometres (4 miles) north of Coboconk, Highway 36 descends a low north-facing scarp of red and green Shadow Lake sediments capped by medium-bedded brown limestone. The Shadow Lake rocks are soft, very thin bedded, dark red arkose interlayered with green limy shale. A 1.2 m (4 feet) channel sample from a point about 5 m (15 feet) below the hard, grey-weathering, limestone caprock, and about the same distance above the Precambrian surface, is represented by sample 63-430.

WHITBY SHALE

Current nomenclature uses the term "Whitby Formation" to include three shale units formerly known by the names Blue Mountain, Gloucester and Collingwood. These shales are blue-grey, brown, and black respectively, and are now referred to as the Upper, Middle, and Lower Members respectively of the Whitby Formation (Liberty 1969, p.65). Because the characteristics of the three shales are distinct they are dealt with separately on the following pages.

COLLINGWOOD SHALE

Brittle black calcareous shale of the Collingwood unit is exposed at Craigleith west of Collingwood, at Sheguiandah on Manitoulin Island, and in a quarry at Bowmanville. It is of no value for clay products or expanded aggregate. Collingwood Shale has also been referred to by the names Craigleith, Utica, Whitby, and Eastview.

Geology

Collingwood Shale is a dark brown to black, brittle, thin-bedded rock that weathers grey, brown, or yellow, with fissile lamination. It is noticeably bituminous and sulphurous, and in some places highly fossiliferous. The trilobite genus Triarthrus is especially well represented near Craigleith on Georgian Bay. The Collingwood unit is 6-18 m (20-60 feet) thick (Caley and Liberty 1957, p.219).

Composition

As exposed at Craigleith and Sheguiandah the Collingwood Shale is highly calcareous and fossiliferous; at Craigleith and Bowmanville it is actually a shaly limestone. Of the clay minerals, illite and chlorite are present in moderate amount. Ignition losses are high, due mainly to the evolution of carbon dioxide through the breakdown of carbonate minerals, but also sulphurous gases from pyrite. Table 3 gives analytical data of several samples.

Ceramic Properties and Utilization

The Collingwood Shale has very low plasticity. Hand-moulded briquettes are weak in the green state, and disintegrate after firing. The shale is quite unsuitable for clay products and expanded aggregate.

GLOUCESTER SHALE

Black shale of the Gloucester unit is exposed near Ottawa and Pickering. The shale is red-burning, and might be suitable for structural clay products; it is also a suitable raw material for expanded aggregate. Gloucester strata have also been variously referred to by the names Billings, Rouge River, Utica, Collingwood, and Whitby.

TABLE 3 ANALYTICAL DATA — WHITBY MIDDLE MEMBER (GLOUCESTER) AND LOWER MEMBER (COLLINGWOOD) SHALES.

SAMPLE DESCRIPTION:

62-401: Duffin Creek bank, 1 mile (1.6 km) north of Pickering; lower 9.3 feet (2.8 m) of Gloucester Shale section.
62-402: Location as above; upper 8.7 feet (2.6 m) of Gloucester Shale section.
62-402A: Location as above; composite of samples 62-401 and 62-402.
62-413: Sheguiandah, Manitoulin Island, Highway 68 roadcut; 8 feet (2.4 m) of hard, black limy Collingwood shale.
62-420: Craigleith; low outcrop near Highway 26; small bulk sample of dark brown platy Collingwood shale.
Bowmanville: St. Mary's Cement Co. Ltd., quarry; 13 foot (4 m) drillcore sample of dark brown shaly limestone. *Courtesy St. Mary's Cement Co. Ltd.

CHEMICAL ANALYSES:

	62-402A %	-413 %	-420 %	Bowmanville* %
SiO_2	57.14	—	—	20.57
Al_2O_3	18.20	—	—	6.50
Fe_2O_3	7.30	2.63	2.67	2.28
CaO	1.69	23.00	31.20	36.80
MgO	2.78	—	—	1.65
Na_2O	0.44	—	—	—
K_2O	4.22	—	—	—
TiO_2	0.88	—	—	—
CO_2	1.04	—	—	—
H_2O+	1.49	—	—	—
SO_3	0.55	—	—	—
Total:	99.98			
Soluble salts		1.07	0.83	—
Loss on ignition	7.13	30.94	31.95	30.44

MINERAL ANALYSES:

	62-401 %	-402 %	-413 %	-420 %
Non-clay minerals:				
Quartz	26	27	14	12
Calcite	ND	ND	35	50
Dolomite	ND	ND	8	1
Soda-lime feldspar	2	2	ND	1
Potash feldspar	0.5	ND	1	1
Clay minerals:				
Illite	A	A	A	B
Chlorite	B	B	B	C
Expanding minerals	D	D	ND	ND

(A = abundant, B = moderate, C = minor, D = trace, ND = not detected).

CERAMIC PROPERTIES:

Sample	% Water of plasticity	% Drying shrinkage	PCE	Fired Characteristics: Cone*	% Firing Shrinkage	% water Absorption: 24-hr. cold	% water Absorption: 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-401	17	2.3	7	010	0.7	12.5	14.4	1.92	Salmon	Hard	All briquettes slightly blistered; sample over fired at cone 03
				06	4.1	5.7	8.0	2.17	Red	Very hard	
				03	5.5	1.2	3.3	2.25	Red-brown	Very hard	
62-402	16	2.3	8	010	1.0	12.6	14.5	1.94	Salmon	Almost hard	Fired briquettes are slightly blistered.
				06	4.1	6.3	8.3	2.16	Salmon-red	Very hard	
				03	6.5	1.0	2.6	2.30	Dark red	Very hard	
62-413	13										Very low plasticity; briquettes disintegrated after firing.
62-420	14										Very low plasticity; briquettes disintegrated after firing.

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), 06 (1840°F), 03 (1980°F).

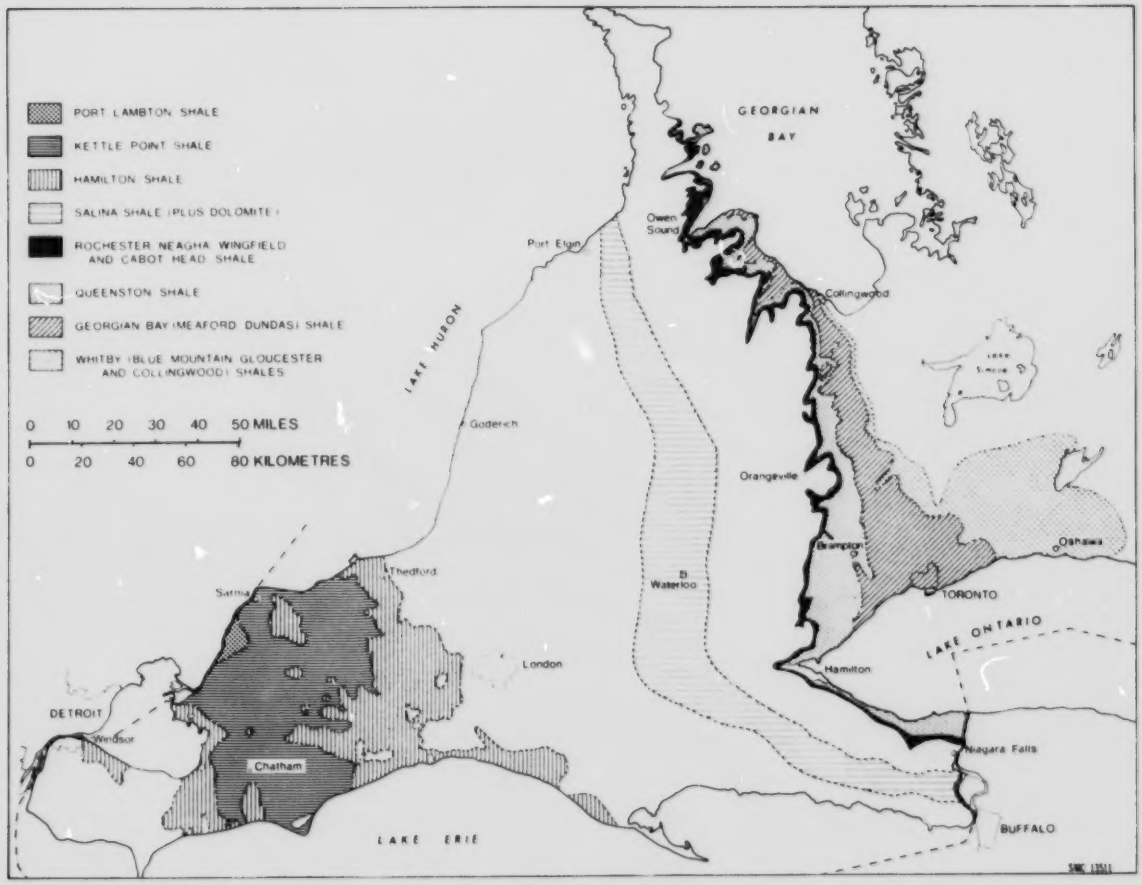


Figure 3 – Shale of Central and Southwestern Ontario.

Geology

Gloucester Shale is a dark brown to black, brittle, thin-bedded rock that weathers grey, brown, or yellow with fissile lamination. It is noticeably bituminous and sulphurous. Near Ottawa the formation probably has a thickness of 8-90 m (26-300 feet) (Wilson 1946, p.27), but near Pickering is about 30 m (90 feet) (Liberty 1969, p.67). The Gloucester Shale is underlain by interbedded limestone and shale of the Eastview Formation near Ottawa, and by the Collingwood Shale at Pickering. It is overlain by Carlsbad (Georgian Bay) Shale at Ottawa, and by Blue Mountain Shale at Pickering.

Composition

Calcite and dolomite are practically absent in the Pickering exposure, and the appreciable loss on ignition reflects, in addition to moisture, the evolution of sulphurous gasses and carbon dioxide from pyrite and organic material (see Table 3). Of the clay minerals, illite is abundant, and chlorite is in moderate amount. Brady and Dean (1966, p.32 and 43) give chemical and mineral data for Billings Shale in the Ottawa area.

Ceramic Properties and Utilization

Brady and Dean (1966, p.27 and 99-101) discuss the physical and ceramic properties of the Billings Shale in the Ottawa area. The shale is of low plasticity, but has a sufficient firing range for structural clay products. The results of ceramic tests on samples from Pickering are shown in Table 3. Shale from Pickering is similar to that from Ottawa. Optimum firing temperature is cone 06 (1004°C; 1840 °F), where the body exhibits steel hardness, medium red colour, and a lineal fired shrinkage of 4 percent. Absorption by 24-hour cold water submersion is 5.7 percent; by 5-hour boiling is 8.0 percent. Test briquettes are blistered at all firing temperatures, perhaps due to too fast a heating rate and incomplete elimination of carbon dioxide and sulphurous gasses. The fusion point (pyrometric cone equivalent) is about cone 7.

The (Utica) shale is also described by Keele (1924, p.14-16) who refers to its use for brick at Ottawa.

The shale shows promise as a raw material for expanded aggregate production. Matthews (1952, p.22-24), reports that tests on Billings Shale at Ottawa indicate that the bloating characteristics are good, but that the vitrification range in some cases is too narrow for making coated aggregate in the rotary kiln.

Distribution and Occurrences

The outcrop area for Gloucester Shale is shown for the Ottawa area (Figure 6). Keele (1924, p.14-15) outlines the distribution of the (Utica) shale. Exposures are scattered in Russell and Carleton counties east of Ottawa; Matthews (1952, p.22-24) describes a number of outcrops.

The Whitby Shale is shown undivided (Figure 3) in central Ontario. In Ontario County several outcrops of Gloucester strata are known in creek banks near Pickering and Whitby, but the formation is generally drift-covered. An exposure near Pickering is described in the following section.

Pickering

A 6 m (20-foot) section of Gloucester Shale is exposed in the west bank of Duffin Creek in the southeast corner of lot 15, concession III, Pickering Township. The section is located at the west end of the bridge on the first concession road north of Pickering. Depth of overburden is 6-9 m (20-30 feet) except in the immediate vicinity of the creek.

The shale is a very thin bedded, grey-brown to black, moderately hard, brittle rock, with occasional interlayers and lenses of very soft, yellowish material. Pyrite is common, associated with much rusty alteration. The shale weathers with a fissile lamination. Samples 62-401 and 62-402 are vertical channel samples of the lower 2.8 m (9.3 feet), measured from 0.6 m (2 feet) above creek level, and the upper 2.6 m (8.7 feet) respectively.

TABLE 4 ANALYTICAL DATA — WHITBY UPPER MEMBER (BLUE MOUNTAIN) SHALE.

SAMPLE DESCRIPTION:

66-443: Camperdown, eroded terrace 1,000 feet (305 m) south of Highway 26; 20 feet (6 m) of soft grey-blue shale.
66-444: Location as above; top 15 feet (5 m) of shale, just above previous sample.
66-445: Location as above; weighted composite of 66-443 and 66-444.
62-410: Highway 68 roadcut 3 miles (5 km) south of Little Current; 8 feet (2 m) of soft grey (Sheguiandah) shale.
62-411: Location as above; 14 feet (4 m) of (Wekwemikongsing) shale near top of section.
62-412: Location as above; top 4 feet (1 m) of oxidized (Wekwemikongsing) shale.
62-412A: Location as above; weighted composite of 62-410, 62-411, and 62-412.

CHEMICAL ANALYSES:

	66-445 %	62-410 %	-411 %	-412 %	-412A %
SiO_2	56.70	—	—	—	53.60
Al_2O_3	16.90	—	—	—	16.30
Fe_2O_3	7.95	6.59	6.62	6.66	6.82
CaO	2.95	1.87	3.44	3.44	2.91
MgO	3.30	—	—	—	4.37
Na_2O	0.65	—	—	—	0.44
K_2O	3.20	—	—	—	5.38
TiO_2	0.84	—	—	—	0.77
CO_2	3.65	—	—	—	3.46
H_2O^+	3.47	—	—	—	3.60
H_2O^-	1.13	—	—	—	0.94
SO_3	1.10	—	—	—	2.31
MnO	—	—	—	—	0.07
Total:	101.80				101.00
Soluble salts		1.02	1.12	2.64	
Loss on ignition	7.99	7.73	7.67	8.50	7.50

MINERAL ANALYSES:

	66-443 %	-444 %	62-410 %	-411 %	-412 %
Non-clay minerals:					
Quartz	27	28	22	21	19
Calcite	2	2	1	2	1
Dolomite	0.5	ND	1	3	4
Soda-lime feldspar	2	3	ND	ND	ND
Potash feldspar	ND	ND	1	1	1
Clay minerals:					
Illite	A	A	A	A	A
Chlorite	A	A	B	A	B
Expanding minerals	ND	D	ND	ND	ND

(A = abundant; B = moderate; D = trace; ND = not detected).

CERAMIC PROPERTIES:

Sample	% Water of Plasticity	% Drying Shrinkage	PCE	Cone*	% Firing shrinkage	Fired Characteristics: % water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
66-443	26	5.8	4½	010	2.0	15.1	15.9	1.82	Salmon	Almost hard	Light scum.
				06	5.3	9.1	9.5	2.05	Red	Very hard	
				03	8.8	0.5	0.6	2.36	Dark Red	Very hard	
66-444	25	5.4	4½	010	2.5	12.7	13.5	1.91	Salmon	Hard	A few lime pops;
				06	6.0	6.6	7.0	2.17	Red	Very hard	moderate scum at
				03	9.5	0.2	0.3	2.35	Dark Red	Very hard	cone 03.
62-410	22	—	6-7	010	—	12.8	15.5	1.89	Salmon	Almost hard	Blotchy colouring:
				06	—	5.9	8.6	2.12	Salmon-Red	Very hard	lime pops com-
				03	—	1.7	5.0	2.00	Red-Brown	Very hard	mon; blistered & overfired at cone 03.
62-411	21	3.6	4	010	1.7	11.2	13.2	2.00	Salmon	Very hard	A few lime pops;
				06	5.4	4.7	6.9	2.23	Salmon-pink	Very hard	slightly overfired
				03	4.5	0.5	2.4	2.09	Brown	Very hard	at cone 03.
62-412	24	4.8	4	010	2.8	11.5	13.3	1.97	Salmon	Very hard	Lime pops com-
				06	6.8	4.3	5.7	2.22	Salmon-brown	Very hard	mon; warped and
				03	7.3	0.2	1.1	1.98	Dark Brown	Very hard	overfired at cone 03.

*Peak temperatures measured by optical pyrometer were 1660°F (cone 010), 1840°F (cone 06), 1980°F (cone 03).

BLUE MOUNTAIN SHALE

Soft, uniform, grey-blue shale of the Blue Mountain unit is Upper Ordovician in age. It outcrops on Georgian Bay west of Collingwood and on Manitoulin Island and occurs beneath the drift on the east side of Toronto. It is correlated with Sheguiandah Shale on Manitoulin Island and Carlsbad Shale at Ottawa. The shale has good plasticity, and burns to a dense red body. It appears to be well-suited for heavy clay products, but it is not known to have been used commercially.

Geology

Blue Mountain Shale is a soft, uniform, grey-blue shale that readily weathers to clay. The shale is very thin bedded with fissile lamination. Hard limy lenses 1.8 cm (½ inch) thick, and rusty-weathering layers, are rare. The formation is sparsely fossiliferous. Thickness is in the range 35-50 m (120-170 feet) in southern Ontario; somewhat less on Manitoulin Island.

Blue Mountain Shale rests on Gloucester shale in the Toronto area. Since the Middle Member (Gloucester) is absent in the Georgian Bay area, the Blue Mountain is underlain directly by the black Collingwood Shale. In all areas Dundas Shale (Georgian Bay Formation) overlies the Blue Mountain without lithologic break; the boundary is drawn at the first conspicuous limy hard layer.

Composition

The composition and properties of Blue Mountain Shale are very like those of Dundas-Meaford shales without the hard layers. Quartz content is moderately high; carbonate content is low. Both illite and chlorite are abundant in the clay fraction. Chemical and mineral analyses of samples from Camperdown and Manitoulin Island are given in Table 4. They indicate a significantly lower quartz content, but higher dolomite content, in the Manitoulin Island samples.

Ceramic Properties and Utilization

Blue Mountain Shale has good plasticity, and burns to a dense, red, well-vitrified body at cone 06. Samples from Camperdown were slightly superior to those from Manitoulin Island in terms of plasticity and fired density and appearance. Ceramic properties of samples from the two areas are detailed in Table 4.

This shale is one of the most promising shales for heavy clay products in Ontario, but the writer is not aware of it ever being used commercially. It appears to have the firing properties of Dundas Shale, plus improved plasticity and freedom from hard layers. Its value for expanded aggregate has not been determined.

Distribution and Occurrences

For the most part the outcrop belt of the Blue Mountain Shale is heavily drift-covered. It is best exposed on the Georgian Bay shore between Craigleith and Thornbury. Exposures are not known further south, but drilling in the floor of the Don Valley quarry of the Toronto Brick Division of United Ceramics Limited has indicated its presence below the Dundas Shale in the Toronto area; it probably underlies the drift in the area between the east part of Toronto and the exposure of Gloucester Shale at Pickering.

On Manitoulin Island the (Sheguiandah) shale outcrops in a narrow belt around the noses of several major promontories in the northeast part of the island (Figure 4). Liberty (1972, Maps 2246 and 2247) shows the outcrop areas in detail.

Camperdown

Blue Mountain Shale is best exposed at Camperdown, 5 km (3 miles) east of Thornbury. Here Highway 26 and the Canadian National Railway line are built on a low terrace 9 m (30 feet) above Georgian Bay.

The terrace extends inland 305 m (1,000 feet) before rising abruptly to a second terrace 45 m (150 feet) above the lake, and this level is maintained for 0.4 km (¼ mile) to the foot of the main bluff of the Escarpment.

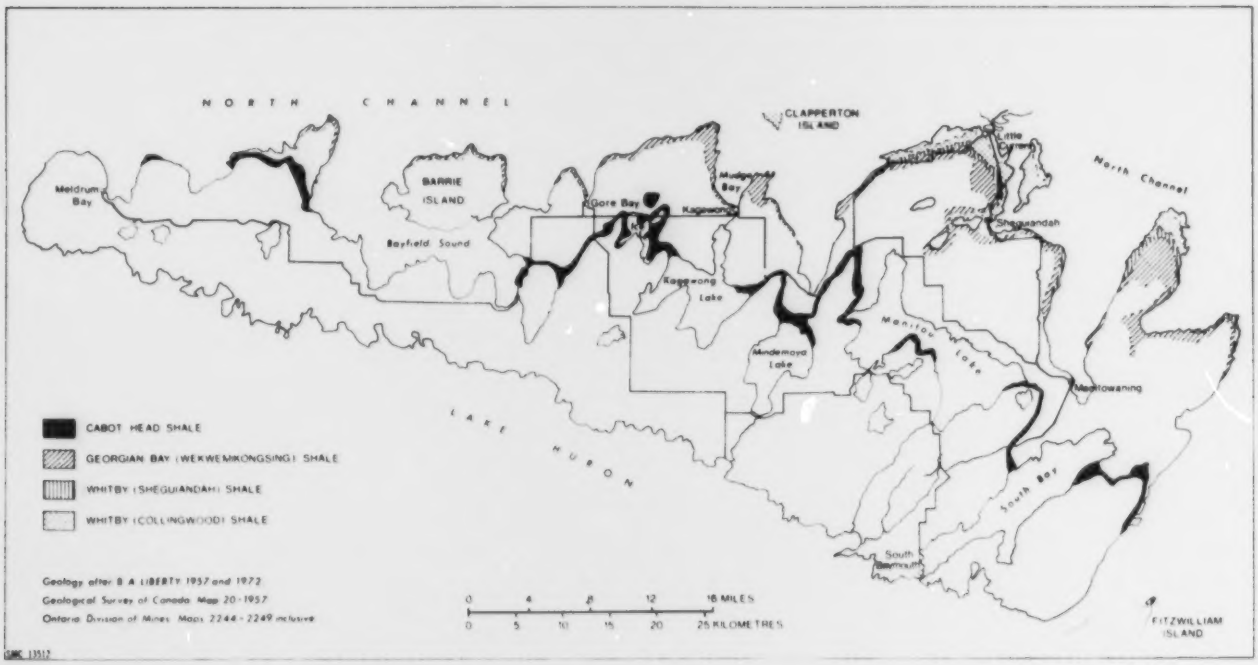


Figure 4 – Shale of Manitoulin Island.

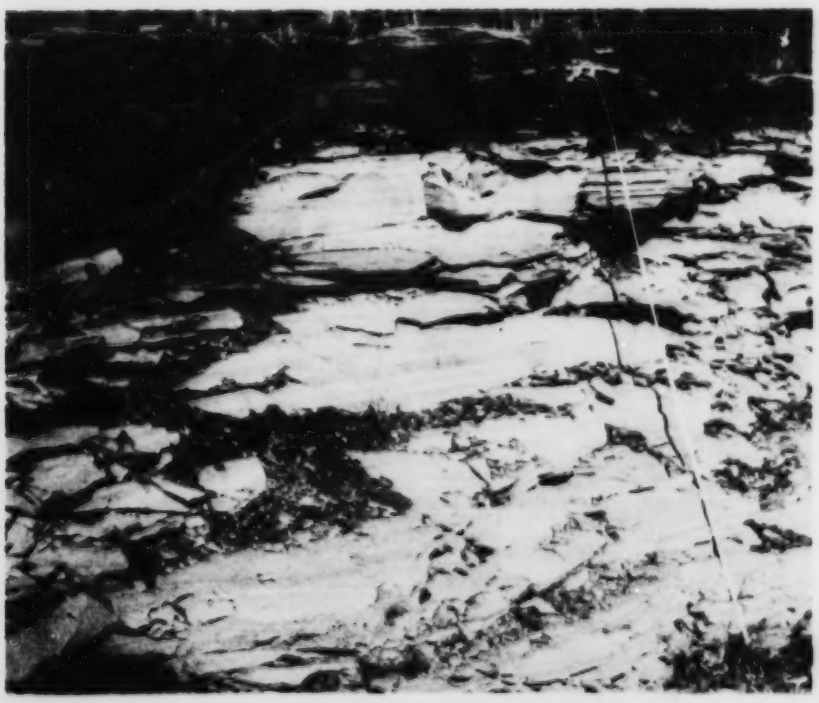


Photo 1 – Georgian Bay shale south of Little Current, Manitoulin Island.

Blue Mountain Shale appears to occupy the 45 m (150 feet) interval between lake level and the second terrace.

The second terrace is cut by several small rivulets, exposing 9-18 m (30-60 feet) of soft shale at the top of the section. The soft-weathering blue-grey shale contains rare hard layers to 1.8 cm (½ inch) thick. Samples 66-444 and 66-443 represent the top 5 m (15 feet) and underlying 6 m (20 feet) respectively. Sample 66-445 is a composite of the two samples.

Little Current

A roadcut on Highway 68, 5 km (3 miles) south of Little Current on Manitoulin Island exposes about 20 m (70 feet) of soft blue-grey shale. The road climbs a north-facing bluff of the shale, and the top 5 m (18 feet) are freshly cut and well exposed. About 12 m (40 feet) of shale below this is poorly exposed in the road bank, but a further 2 m (8 feet) of similar shale is well exposed at a culvert 305 m (1,000 feet) north of the crest of the bluff. The entire section is here included as Sheguiandah Shale, although the upper part belongs more correctly to the Georgian Bay Formation according to mapping by Liberty (1972, Map 2247).

The 5 m (18 feet) section exposed in the roadcut consists of 4 m (14 feet) of unweathered shale overlain by 1 m (4 feet) of very soft, almost earthy, olive-coloured oxidized shale. The unweathered shale is thin-medium bedded, soft and platy, and blue-grey in colour. Fossils are fairly common, particularly brachiopods, and are occasionally concentrated in soft limy lenses 0.6 cm (¼ inch) thick. Small vugs lined with translucent white gypsum crystals, and thin plates of the same mineral, are occasionally present in the shale. Samples 62-411 and 62-412 are vertical channel samples of the 4 m (14 feet) of unweathered shale and the 1 m (4 feet) of oxidized shale respectively.

Shale of the 2 m (8 feet) section is very soft, uniform, and medium grey in colour. It weathers with a fissile lamination and is oxidized olive-buff near the top. There are no hard layers, and only minor efflorescence. Sample 62-410 is a vertical channel sample of the 2 m (8 feet) section. Sample 62-412A is a weighted composite of all three samples.

GEORGIAN BAY SHALE

Widely known formerly by the names Meaford and Dundas the Georgian Bay Shale consists of two similar and conformable shale units overlying shales of the Whitby Formation. The units themselves are compositionally similar, consisting of moderately soft shale blue-grey to green-grey in colour. The units were previously distinguished from one another only with difficulty, the distinction being based on the frequency of hard limy or sandy layers and fossil content. Georgian Bay Shale underlies the Toronto area as far west as Streetsville, and persists beneath the drift along the base of the Niagara Escarpment to Georgian Bay. The name Wekwemikongsing was formerly applied on Manitoulin Island to the Dundas unit. In the Ottawa area the names Carlsbad and Russell were formerly correlated with the Dundas and Meaford respectively. Lorraine, Hudson River, and Richmond are other names that have been applied to Georgian Bay rocks.

Georgian Bay Shale is the principal raw material used by three brick plants and one expanded aggregate plant. The shale burns to a salmon-red, dense, hard body of relatively low absorption.

Geology

Shale of the Georgian Bay Formation is a moderately soft, thin-medium bedded, medium grey rock with platy lamination. Hard limy and sandy interlayers comprise 10-20 percent of most exposed sections. Fossils are locally common.

The Dundas unit is more than 120 m (400 feet) thick at Toronto; it was divided in ascending order into Rosedale, Danforth, Humber, and Credit Members (Parks 1925). At Meaford a 75 m (250 feet) section has been measured by Fritz (1926) and divided into Rosedale, Danforth, Humber, and Christie Members.

The Dundas unit is more completely described in a previous volume (Guillet 1967, p.31-55).

The Meaford unit consists of grey fissile shale and interstratified hard layers of brown limestone and grey calcareous sandstone; hard layers increase in frequency towards the top. A 33 m (108 feet) section measured above the Dundas beds on East Meaford Creek has been

TABLE 5 CHEMICAL AND MINERAL ANALYSES – GEORGIAN BAY SHALE.

SAMPLE DESCRIPTION:

Pure shale:	Average analysis of the pure shale from 7 locations (Keele 1924, p.19).
Limy layer:	Analysis of typical hard limy layer (Parks 1925, p.97).
Sandy layer:	Analysis of typical hard sandy layer (Parks 1925, p.97).
Av. Dundas:	Average of channel samples from 4 brick quarries (Guillet 1967, p.35).
62-403:	West branch of Humber River at 8th Line road, Toronto Gore Tp.; 16 feet (5 m) of grey shale.
63-437:	Quarry of St. Lawrence Cement Co. Ltd., Clarkson; 16 feet (5 m) of grey shale.
66-438:	Meaford Creek, north of Highway 26; 25 feet (8 m) of soft blue-grey shale of the Rosedale Member.
66-439:	Location as above; 38 feet (11.5 m) of soft grey shale from the lower part of the Danforth Member.
66-440:	Location as above; 30 feet (9 m) of soft grey shale from the upper part of the Danforth Member.
66-441:	Location as above; 30 feet (9 m) of soft green-grey shale from the lower part of the Humber Member.
66-442:	Location as above; composite of 66-438, -439, -440, -441.
62-414:	5 miles (8 km) northeast of Gore Bay, Manitoulin Island; 7 feet (2 m) of soft grey shale from creek bank.

CHEMICAL ANALYSES:

	Dundas Shale											
	Pure shale	Limy layer	Sandy layer	Av. Dundas	62-403	63-437	66-438	66-439	66-440	66-441	66-442	62-414
	%	%	%	%	%	%	%	%	%	%	%	%
SiO_2	58.74	34.7	63.6	55.66	—	—	—	—	—	—	57.00	—
Al_2O_3	17.90	9.0	15.0	15.30	—	—	—	—	—	—	15.90	—
Fe_2O_3	7.50	—	—	6.60	6.82	6.79	7.28	7.28	7.35	7.58	7.75	6.58
CaO	2.37	30.3	7.3	4.63	3.88	3.98	2.68	2.67	2.65	3.40	3.05	2.73
MgO	2.84	trace	trace	2.82	—	—	—	—	—	—	3.19	—
Na_2O	4.03	—	—	0.93	—	—	—	—	—	—	0.54	—
K_2O	—	—	—	3.51	—	—	—	—	—	—	3.22	—
TiO_2	—	—	—	0.89	—	—	—	—	—	—	0.84	—
CO_2	8.26	24.7	9.3	4.06	—	—	—	—	—	—	3.30	—
H_2O^+	—	—	—	3.38	—	—	—	—	—	—	3.88	—
H_2O^-	—	—	—	1.00	—	—	—	—	—	—	1.05	—
SO_3	—	—	—	0.78	—	—	—	—	—	—	1.40	—

MINERAL ANALYSES:

	Dundas Shale								
	Average	Range	62-403	63-437	66-438	66-439	66-440	66-441	62-414
	%	%	%	%	%	%	%	%	%
Non-clay minerals:									
Quartz	28	23-35	25	29	29	36	31	28	27
Calcite	7	3-17	5	5	0.5	2	2	3	2
Dolomite	1	0-4	ND	3	0.5	2	0.5	0.5	1
Soda-lime feldspar	3	0.5-8	1	5	0.5	1	0.5	2	1
Potash feldspar	0.5	0-3	1	1	0.5	0.5	ND	0.5	1
Clay minerals:									
Illite	A	A	A	A	A	A	A	A	A
Chlorite	B	B	B	A	A	A	A	A	B
Expanding minerals	ND	ND	C	—	D	D	—	D	ND

(A = abundant; B = moderate; C = minor; D = trace, ND = not detected)

TABLE 6 CERAMIC PROPERTIES – GEORGIAN BAY SHALE.

CERAMIC PROPERTIES:

Sample	% water of Plasticity	% Drying Shrinkage	PCE	Fired Characteristics: Cone*	% Firing Shrinkage**	% water Absorption: 24-hr. cold	% water Absorption: 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
Average Dundas Shale	18	2.3	5	010	0.1	13.1	14.6	1.94	Pale salmon	Almost hard	Blistered and overfired at cone 03.
				06	0.6	11.7	13.8	1.97	Salmon	Hard	
				03	2.4	4.3	6.8	2.20	Dark brown	Very hard	
62-403	18	2.5	5	010	0.7	12.2	14.1	1.96	Salmon	Hard	Blistered and overfired at cone 03.
				06	2.2	9.8	12.0	2.03	Pale Red	Hard	
				03	4.3	1.4	3.0	2.18	Dark Brown	Very hard	
63-437	16	2.0	5	010	+0.3	12.8	14.8	1.93	Pale Salmon	Almost hard	Light scum.
				06	0.3	11.4	13.5	1.97	Pale Salmon	Hard	Heavy scum.
				03	3.2	6.8	9.1	2.10	Pink-Red	Very hard	Scum; slightly blistered.
66-438	26	5.2	5	010	1.4	13.8	14.4	1.90	Salmon	Almost hard	A few lime pops.
				06	5.6	6.6	7.4	2.17	Red	Hard	
				03	8.6	4.0	0.5	2.37	Red-Brown	Very hard	
66-439	26	5.3	5	010	1.2	15.1	15.8	1.85	Salmon	Almost hard	Lime pops.
				06	4.8	8.5	9.6	2.07	Pale Red	Hard	
				03	5.6	0.9	1.0	2.38	Red	Very hard	
66-440	25	5.2	5	010	1.1	16.4	18.5	1.79	Salmon	Almost hard	Lime pops.
				06	3.3	11.6	13.4	1.92	Red	Hard	
				03	7.2	4.4	6.1	2.17	Dark Red	Very hard	
66-441	25	4.9	5	010	1.2	14.9	15.9	1.84	Salmon-brown	Almost hard	Lime pops.
				06	4.7	8.6	9.7	2.05	Brown	Hard	Scum.
				03	6.7	3.3	3.5	2.25	Red-Brown	Very hard	Heavy scum.
62-414	22	4.1	3-4	010	1.7	11.7	13.2	1.97	Salmon	Hard	A few lime pops; warped and over-fired at cone 03.
				06	4.5	5.5	7.0	2.20	Salmon-red-brown	Hard	
				03	4.5	0	0.1	2.12		Very hard	

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), 06 (1840°F), 03 (1980°F).
**A plus (+) sign indicates expansion.

divided into Erindale and Vincent Members in ascending order (Fritz 1926).

In the Ottawa area the Carlsbad and Russell Shales are similar to the Dundas and Meaford Shales respectively. They are described by Wilson (1946, p.28-30).

On Manitoulin Island the Formation previously designated as the Wekwemikongsing consists of soft, grey or blue-grey, thin-bedded shale, interlayered with occasional hard sandy, limy, and fossiliferous beds. It appears to occupy a position equivalent to the upper members of the Dundas unit (Caley 1936, p.35). The former Wekwemikongsing Shale is overlain by the Meaford unit which on Manitoulin Island consists of dolomitic limestone instead of shale. The shale unit is 45-100 m (150-330 feet) thick (Liberty 1957) and is now referred to as the Lower Member of the Georgian Bay Formation.

Drilling by the Ontario Hydro at the site of the Delphi Point generating station, 3 km (2 miles) west of Craigleith, indicates a combined thickness of 120 m (400 feet) for the Meaford and Dundas Shales (Figure 5). The frequency of limestone layers in the Meaford unit is noticeably greater than in the Toronto area, and the facies change is complete on Manitoulin Island where the Meaford is represented by argillaceous limestone, now referred to as the Upper Member of The Georgian Bay Formation.

Composition

The shales of the Georgian Bay Formation do not vary appreciably in composition, but as the frequency of hard layers increases upwards through the sequence so also does the overall lime content. Chemical analyses of the pure shale, and of both the limy and sandy interlayers, are reproduced from Keele (1924, p.19) and Parks (1925, p.97) in Table 5. The average composition of complete sections (shale plus hard layers) of Dundas Shale exposed in four active brick quarries in the Toronto area is also given. Mineral composition for the same composite, and the range for the fifteen vertical channel samples that make up the composite, is shown in Table 5. Clay minerals comprise about 60 percent of the Dundas sections.

White efflorescence is common on exposed surfaces of Georgian Bay Shale, but gypsum is not observed in discreet units as it is in Queenston Shale. Pyrite (FeS_2) is sometimes present in hard sandy layers.

Ceramic Properties and Utilization

Georgian Bay Shale is the major raw material in brick made by Domtar Construction Materials Limited at Cooksville, and Toronto Brick Company Limited in the Don Valley. A brick and tile plant at the Ontario Reformatory (Mimico) was closed in 1968, and the two plants of Booth Brick Company Limited were closed in 1972. The shale is also used for expanded aggregate by Domtar Construction Materials Limited at Cooksville. Detailed studies of the quarry sections at these plants and the results of chemical, mineral, and ceramic testing of the shale are contained in a previous volume (Guillet 1967, p.34-55). Brady and Dean (1966) show comparable results for samples from the same quarries; some of their samples have also been investigated by D.T.A. and other thermal methods. Table 6 gives ceramic properties for a number of samples.

Georgian Bay Shale has just sufficient plasticity for modern extrusion machines. It has a low drying and firing shrinkage and a moderate firing range. The shale burns to a smooth-textured, hard, salmon-red body with an absorption of 12-14 percent. For expanded aggregate the shale bloats well and has a moderately good firing range. Its commercial value for the making of a crushed sintered aggregate in the rotary kiln has been demonstrated since 1928, in the commercial product "Haydite". In 1968 the Cooksville plant of Domtar Construction Materials Limited commenced production of a coated aggregate in addition to its Haydite line.

Distribution and Occurrences

Figure 3 shows the outcrop belt for Georgian Bay Shale in south central Ontario. The outcrop area for Carlsbad and Russell shales in the Ottawa area is shown in Figure 6. Figure 4 shows the area underlain by the Wekwemikongsing Shale on Manitoulin Island.

The Georgian Bay Formation is well-exposed along the Humber River and in several brick quarries in the Toronto area. Exposures are absent from just north of Woodbridge to Georgian Bay, but on the shore at Meaford and

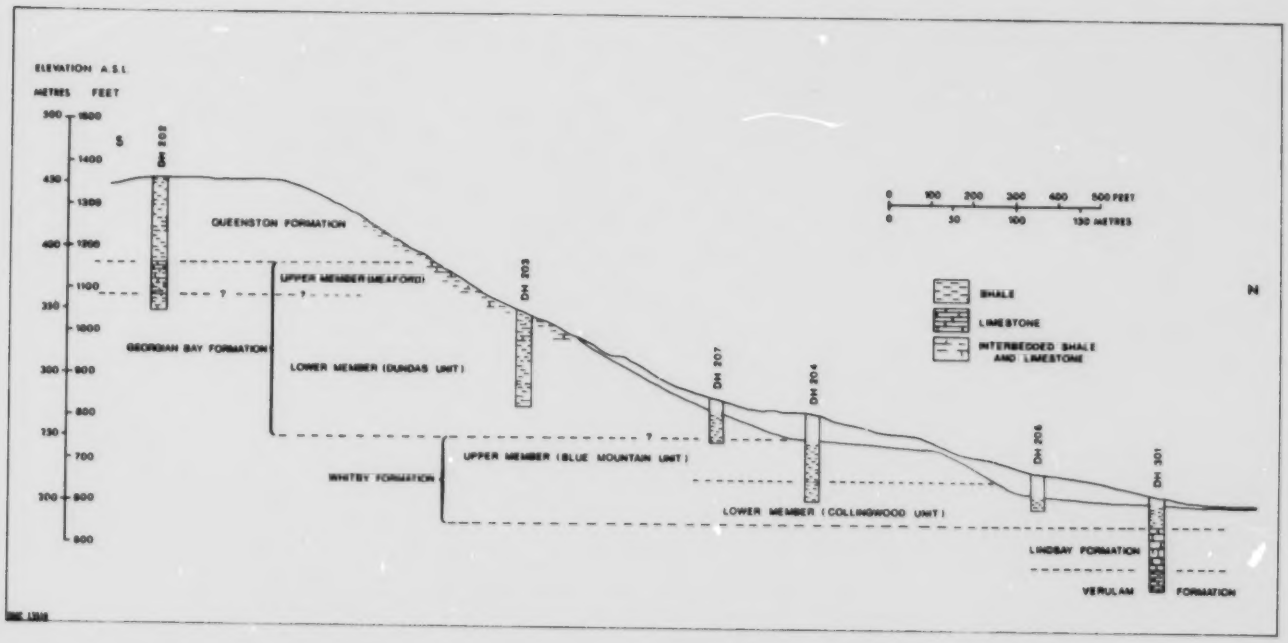


Figure 5 – Geological section of the Niagara Escarpment at Georgian Bay.

Photo 2 – Georgian Bay Shale along the Humber River south of Albion Road.

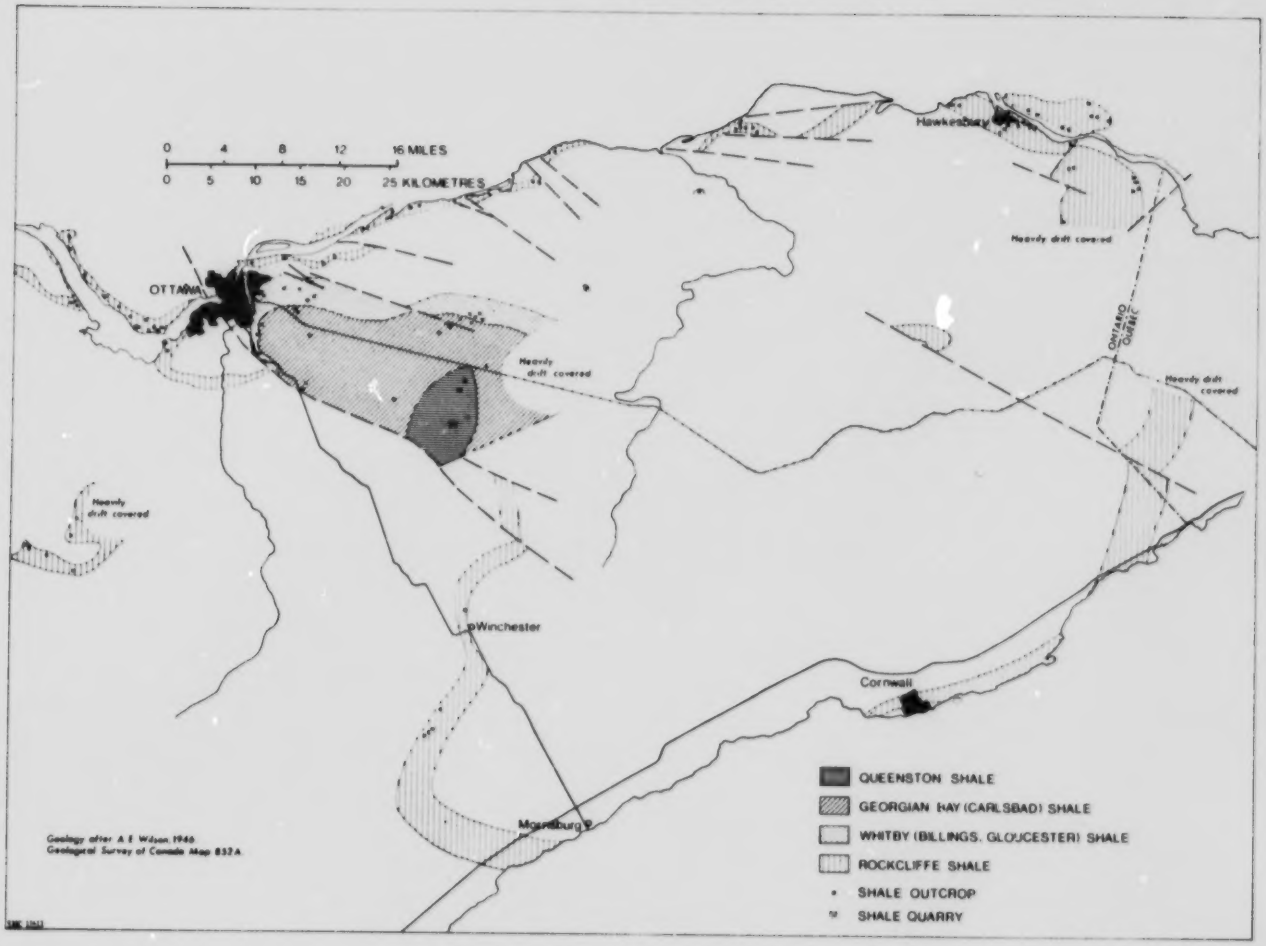


Figure 6 – Shales of the Ottawa-Cornwall area.

in the banks of East Meaford Creek good sections are exposed.

The Meaford unit is best exposed at Meaford on Georgian Bay where a 33 m (108 feet) section has been measured above the Dundas beds on East Meaford Creek (Fritz 1926). Meaford Shale is also exposed along the Credit River near Streetsville and Erindale, and on Etobicoke and Mimico Creeks, and Humber River, east and north of Brampton.

Descriptions of several sections of Georgian Bay Shale in the Toronto area follow. Sections in the active brick quarries are described in a previous report (Guillet 1967, p.34-55).

Woodbridge

An exposure of Georgian Bay Shale in lot 7, concession VIII, Township of Toronto Gore, occurs on the west branch of the Humber River 8 km (5 miles) west of Woodbridge and 0.8 km (½ mile) north of Highway 7. The exposure is in the north bank of the river, 90 m (100 yards) west of the bridge on the 8th Line road.

The section consists of 7.6 m (25 feet) of shale overlain by 3-4.6 m (10-15 feet) of brown-weathering till. Hard layers 2.5-7.5 cm (1-3 inches) thick comprise 10-15 percent of the shale section. The shale is moderately soft, very thin bedded, medium grey-green, weathering to pale grey with platy lamination. Some rustiness and minor white efflorescence is present on the weathered surfaces. Ripple marks, and various crinoid, pelecypod, and bryozoa fossils are especially associated with the hard layers. Sample 62-403 represents the lower 5 m (16 feet) of shale.

In 1967 four diamond-drill holes were put down at 180 m (600 feet) intervals south of the Humber River (west branch) in lot 6, concession IX, Toronto Gore Township. Overburden (glacial till) varied from 5-7 m (16-23 feet). The deepest hole penetrated 31 m (101 feet) of Dundas Shale that contained 10 percent of hard layers. The other holes were stopped after penetrating 6 m (20 feet) of shale. The proportion of hard layers in the top 6 m (20 feet) of shale was surprisingly variable, ranging from 8 to 26 percent in the four holes.

Thistletown

Georgian Bay Shale is exposed at a number of points west of Thistletown in banks of the west branch of the Humber River. A section was examined in the north bank in lot 33, concession VII, Etobicoke Township, 0.4 km (¼ mile) south of Albion Road. Residential development of the immediate area precludes its use as a quarry site.

The 8 m (25 feet) section is overlain by 6 m (20 feet) of till at this point. Hard layers, comprising about 25 percent of the shale section, consist of very thin stratified grey-brown sandy beds and nodular brown fossiliferous limestone. Oxidation extends to the middle of the section, the shale above being yellow-buff in colour. Unoxidized shale is thin-bedded and green-grey in colour; it weathers with a platy lamination to a pale grey colour, mottled with some rustiness on joints and fractures. The section was not sampled because of the abundance of hard layers and the commercial unavailability of the site.

Clarkson

St. Lawrence Cement Company Limited operates a quarry in Georgian Bay Shale at its lakeshore plant in Clarkson. The shale is used in small amount with limestone for the manufacture of Portland cement.

The 5 m (16 feet) section consists of moderately soft, platy, green-grey and brown-grey shale, with a few (5-10 percent) hard grey-brown limestone layers and lenticular bryozoan pods (reefs). Sample 63-437 is a vertical channel sample of the 5 m (16 feet) section excluding hard layers more than 1.2 cm (½ inch) in thickness.

Meaford

The most complete section of Georgian Bay Shale may be seen in the banks of East Meaford Creek (formerly Workman's Creek) on the east side of the town of Meaford. M.A. Fritz (1926) made a detailed study of the 110 m (362 feet) section, and recognized the following members in the thicknesses indicated:

Formation	Member	Thickness feet	metres
Meaford	Vincent	25	7.6
	Erindale	83	25.3
Dundas	Christie	67	20.4
	Humber	91	27.7
	Danforth	68	20.7
	Rosedale	25	7.6
Blue Mountain		3	0.9

The writer followed the creek bed from its mouth south to Highway 26, a distance of about 1.6 km (1 mile), taking four chip samples as follows:

Sample 66-438: Rosedale Member; 8 m (25 feet) of very thin bedded, platy-weathered, soft, blue-grey shale containing rare brown limy hard layers.

Sample 66-439: Danforth Member, lower part; 12 m (38 feet) of thin-bedded, platy, soft, grey shale containing 10-15 percent hard layers.

Sample 66-440: Danforth Member, top part; 9 m (30 feet) of shale similar to previous sample.

Sample 66-441: Humber Member, lower part; 9 m (30 feet) of thin-bedded, soft, platy, green-grey shale, containing thin rusty-weathered hard layers every 0.3-0.6 m (1-2 feet).

Sample 66-442: Composite sample of the previous four samples.

Gore Bay, Manitoulin Island

The Wekwemikongsing Shale outcrops near the water's edge around most of the major promontories along the north shore of Manitoulin Island. Eight kilometres (5 miles) northeast of Gore Bay it forms the shoreline for lots 24 and 25. Here the shale is capped by a weather resistant dolomitic limestone that forms a steep bluff along much of the north shore of Manitoulin Island. A 6 m (20 feet) bank of shale is poorly exposed at the water's edge, but several sections up to 2 m (8 feet) thick are well exposed in a small creek valley that cuts the shale on a gradual slope for 0.4 km (¼ mile), before rising sharply through the dolomitic cap.

Lithologically the shale is typical of the Dundas unit. It is thin-bedded, moderately soft, medium grey and weathers to pale grey with platy lamination. Hard green-grey sandy layers, and rare brown limy layers, are typically 5-15 cm (2-6 inches) thick and spaced at stratigraphic intervals of 0.6-2 m (2-6 feet). Fossils are rare, and white efflorescence was noted in only trace amounts on the dry weathered shale. A 2 m (7 feet) section occurring in the creek bed 180 m (200 yards) from the lake shore comprises sample 62-414. Two 7.5 cm (3 inch) hard layers in the section were not sampled.

Little Current

An exposure of Wekwemikongsing Shale 5 km (3 miles) south of Little Current on Manitoulin Island is described with Sheguiandah Shale in the Whitby Formation. Test results on samples 62-411 and 62-412 are given in Table 4.

QUEENSTON SHALE

Shale of the Queenston Formation is the major raw material for ten brick and tile plants in Ontario. The shale overlies the Georgian Bay Formation and is easily recognized by its brick-red colour. It outcrops in a belt from Streetsville west to Milton, extending north and south along the lower terraces of the Niagara Escarpment. A small outcrop of the shale occurs near Ottawa, but on Manitoulin Island the Queenston is represented by limestone and dolostone. Queenston Shale was formerly known by the name Medina.

Geology

The Queenston Formation is Upper Ordovician in age, and it occupies a position at the top of the Ordovician System in Ontario. It overlies the grey Georgian Bay Shale and is interlayered with it through a thickness of about 6 m (20 feet) at the contact. Queenston Shale is sharply overlain by Whirlpool Sandstone of Silurian age. Thickness of the Queenston

Formation is about 180 m (600 feet) in the Hamilton area, decreasing to the north. Fossils are practically absent.

Queenston Shale is predominantly brick-red, thin to thick-bedded, and moderately soft. Thin green bands parallel to the bedding, and more rarely at right angles to it, have been formed by the reducing action of acidic groundwaters. Green Shale constitutes 5-25 percent of most Queenston sections. Queenston Shale is readily broken down by weathering, forming ultimately a red clay soil with superior ceramic properties.

Composition

The Queenston Shale is remarkably uniform in chemical and mineral composition from top to bottom of the formation; minor variations have been pointed out in a previous report (Guillet 1967, p.59). Lime content is most variable, ranging 3-18 percent in brick quarries of the Toronto-Hamilton area, reflecting the proportion of green shale beds in the sampled section. Green shale is harder, more limy and less easily broken down by weathering. Colour and porosity of the fired ware is therefore dependent to a large extent on the proportion of green shale in the section. However, carbonate content of the red shale increases northward, and at Owen Sound the shale burns to a buff porous body.

The average chemical compositon of Queenston Shale from nine quarries in the Toronto-Hamilton area is shown compared to a sample of weathered shale and samples from Owen Sound in Table 7. Other analyses are given by Baker (1906, p.8, samples 18-24 incl.), Keele (1924, p.22), Montgomery (1930, p.23), Brady and Dean (1966, p.32, samples 1-7 incl. and 9) and Guillet (1967, p.57-102).

Clay minerals comprise 60 percent of the shale; illite predominates, and chlorite is present in moderate amount. Quartz and calcite are the major non-clay minerals. The average mineral composition, and the range of variation, for shale from thirteen brick quarries in the Toronto area is shown in Table 7 along with that for two samples from Owen Sound. Mineral compositions for individual quarry samples are detailed by Brady and Dean (1966, p.43) and Guillet (1967, p.60-102).

Ceramic Properties and Utilization

Queenston Shale has a moderate firing range and, in most cases, a pale red fired colour; both the firing range and the colour are improved in the weathered shale. Fired colour and porosity also varies markedly with the proportion of green shale, which by itself is buff-burning due to a higher lime content. The average ceramic properties of fresh unweathered shale from ten brick quarries in the Toronto-Hamilton area are shown in Table 7, compared with the properties of deeply-weathered shale from four quarries and those of the two Owen Sound samples. The shale is widely used in southern Ontario for brick, drainage tile, and various types of structural tile.

Other ceramic test results are given by Keele (1924, p.22), Montgomery (1930, p.23), Brady and Dean (1966, p.24-25), and Guillet (1967, p.60-102). Brady and Dean (1966) also give the results of DTA (differential thermal analysis) and other thermal studies of various Queenston samples.

Weathered Queenston Shale is used in some cases as the major body constituent in various pottery and artware products. The soft shale is prepared by blunging and filter-pressing, and is used either as a slip in plaster moulds, extruded as flowerpot blanks, or thrown on the potters wheel.

Queenston Shale has not been used in Ontario for expanded aggregate. Sections of the shale vary from poor to good in bloating characteristics, but the bloating takes place almost at the point of fusion, making the shale unsatisfactory for coated aggregate production in the rotary kiln. As with most shales and clays a travelling-grate sintered product is possible.

Distribution and Occurrences

The Queenston Shale outcrop belt in south-central Ontario is shown in Figure 3. Exposures are found along the base of the Niagara Escarpment from Niagara Falls to the Bruce Peninsula. Good sections may also be seen in the banks of the Credit River, Oakville and Bronte Creeks, and the Lake Ontario end of the Niagara River. Quarry sections at Milton, Brampton, Streetsville, Cheltenham, Tansley, Waterdown, Grimsby,

TABLE 7 ANALYTICAL DATA — QUEENSTON SHALE.

SAMPLE DESCRIPTION:

Fresh shale: Average of channel samples from brick quarries in the Toronto-Hamilton area (Guillet 1967, p.58).
Weathered shale: Typical of the Toronto-Hamilton area (Guillet 1967, p.58).
Average shale: Average of 45 channel samples from 13 brick quarries in the Toronto-Hamilton area (Guillet 1967, p.58).
62-421: Third Ave. East, Owen Sound; lower 30 feet (9 m) of red shale.
62-422: Location as above; top 8 feet (2 m) of weathered shale.
62-422A: Location as above; composite of 62-421 and 62-422.

CHEMICAL ANALYSES:

	Fresh shale Average %	Weathered shale %	62-421 %	62-422 %	62-422A %
SiO_2	51.28	56.28	—	—	38.10
Al_2O_3	13.90	16.00	—	—	11.80
Fe_2O_3	6.15	6.77	5.38	5.17	5.47
CaO	9.00	4.74	14.40	13.60	14.70
MgO	3.48	2.55	—	—	6.03
Na_2O	0.58	0.70	—	—	0.42
K_2O	3.60	3.93	—	—	3.83
TiO_2	0.72	0.85	—	—	0.61
CO_2	7.29	3.81	—	—	14.98
H_2O^+	2.73	3.21	—	—	2.60
H_2O^-	0.80	0.92	—	—	0.63
SO_3	0.26	0.33	—	—	Nil
MnO	—	—	—	—	99.30
Total:	99.80	100.10			99.30
Loss on ignition			18.47	18.45	18.33
Soluble salts			0.75	1.30	

MINERAL ANALYSES:

	Average shale %	Range %	62-421 %	62-422 %
Non-clay minerals:				
Quartz	26	18-34	19	14
Calcite	11	2-30	15	19
Dolomite	1.8	0-8	20	20
Soda-lime feldspar	1.3	0-7	ND	1
Potash feldspar	trace	0-2	1	1
Clay minerals:				
Illite	A	A-B	A	A
Chlorite	B	B-C	C	C
Expanding minerals*	D	C-ND	C	ND

*Vermiculite
(A = abundant; B = moderate; C = minor; D = trace; ND = not detected).

CERAMIC PROPERTIES:

Sample	% water of Plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	% water Absorption: 24-hr. cold	% water Absorption: 5-hr boiling	Specific Gravity	Colour	Hardness	Remarks
					Fired Characteristics						
Fresh shale average	17	3.2	4	010	0	13.4	14.2	1.87	Salmon	Almost hard	Briquettes are slightly overfired at cone 03.
				06	0	12.3	15.2	1.88	Red	Hard	
				03	0.9	8.5	11.5	1.97	Brown	Very hard	
Weathered shale average	20	3.8	5	010	0.5	12.1	13.5	1.93	Salmon	Almost hard	Briquettes are undeformed but almost overfired at cone 03.
				06	2.1	9.0	11.0	2.01	Salmon-red	Hard	
				03	3.5	4.0	5.5	2.18	Red-brown	Very hard	
62-421	18	3.4	6	010	0.2	19.8	23.0	1.69	Salmon	Almost hard	All are attractive undeformed briquettes with slight scum.
				06	+0.5	19.8	24.0	1.68	Pink-buff	Almost hard	
				03	+0.3	18.8	25.4	1.67	Buff	Almost hard	
62-422	21	4.5	6	010	0.4	18.4	21.7	1.65	Salmon	Hard	All are attractive briquettes, particularly at cone 03 but with slight scum.
				06	0.5	16.7	22.1	1.65	Pink-buff	Hard	
				03	0.5	15.9	23.9	1.65	Buff	Hard	

*Peak temperatures measured by optical pyrometer were 1660°F (cone 010), 1840°F (cone 06), 1980°F (cone 03).
**A plus (+) sign indicates expansion.

and St. Catharines are described in a previous report (Guillet 1967, p.60-102).

Queenston Shale also outcrops 26 km (16 miles) southeast of Ottawa (see Figure 6) where it is quarried for the Ottawa brick plant of Domtar Construction Materials Limited. The plant and quarry have already been described by Guillet (1967, p.76-78); extensive test work on the shale is discussed by Brady and Dean (1966, p.85-90).

A section of Queenston Shale at Owen Sound is described in the following notes.

Owen Sound

A 12 m (38 feet) section of Queenston Shale is exposed on the south side of Third Avenue East in the northeast outskirts of Owen Sound. It comprises a north-facing scarp 75 m (250 feet) long with a flat peneplained top covered by about 1 m (4 feet) of brown clay overburden. The shale is moderately hard, medium-bedded, and vertically jointed at intervals of 1-2 m (2-6 feet). It exhibits blocky weathering. Green shale comprises 5 percent of the section in lenses 2.5-5 cm (1-2 inches) thick. Large (15 cm; 6 inch) salmon-coloured gypsum nodules occur at horizontal intervals of 1-3 m (4-10 feet) in a narrow zone 2 m (8 feet) above the floor. The top 2 m (8 feet) of the section is deeply weathered, friable and loamy. Two vertical channel samples, 62-421 and 62-422, represent the lower 9 m (30 feet) minus the gypsum, and the upper weathered 2 m (8 feet) section respectively. Sample 62-422A is a composite of the two samples.

CABOT HEAD SHALE

Shale of the Cabot Head Formation is the lowest shale unit of the Silurian in Ontario. It is exposed in a few places in the Niagara Escarpment where it is separated from the Queenston Shale below by thin zones of sandstone and dolomite. It is also present on Manitoulin Island. Cabot Head Shale is generally blue-grey but may be green or red in some localities. It is moderately soft, very thin-bedded, and contains a few interbeds of red shale and harder layers of sandy and limy character. Power Glen, Grimsby, and Thorold rocks are related to the Cabot Head; all belong to the Cataract Group of Lower Silurian age.

The Cabot Head Shale has never been used commercially for ceramic products; exposures suitable for commercial utilization are lacking in the Lake Ontario industrial region. The weathered shale on Manitoulin Island is particularly attractive as a ceramic raw material, having good plasticity and burning to a dense salmon body at a low temperature.

Geology

The Cabot Head Shale consists of blue-grey, green-grey, or red shale interlayered with a few hard limy or sandy beds. The shale is typically very thin-bedded, soft, uniform, and readily broken down by weathering. In the Lake Ontario portion of the Niagara Escarpment the presence of the red Grimsby facies near the top of the formation is indicated by a few red shale beds interlayered with the grey shale. The Grimsby beds consist of very thin-bedded, red-brown, green mottled, sandy shale. A thin zone of interlayered green shales and sandstones above the Grimsby is also included in the Cabot Head Shale; it may be the northern equivalent of the Thorold Sandstone (Bolton 1957, p.17). South and east of Hamilton the Power Glen Shale and part of the Grimsby Formation are together equivalent to the Cabot Head. The shale section here is less pure, containing about 30 percent hard limy sandstone beds. The Cabot Head Formation is 12-36 m (40-120 feet) thick.

Cabot Head rocks are separated from the Queenston Shale below by two relatively thin formations: the Whirlpool Sandstone and the Manitoulin Limestone. Interlayering of shale and dolostone occurs over a vertical range of several feet of the Cabot Head-Manitoulin contact zone. The upper limit of the Cabot Head Formation is sharp. From Lake Ontario north the Cabot Head Shale, including Grimsby and Thorold facies, is sharply overlain in the southern part by the Reynales Dolomite, in the central area to Owen Sound by the Fossil Hill Dolomite, and in the Bruce Peninsula and Manitoulin Island by the Dyer Bay Dolomite (Bolton 1957, p.18).

More recent studies by Liberty (1971, p.33-37) include the Wingfield Shale as a member of an expanded Cabot Head Formation. Typical Cabot Head Shale as described herein is also reduced to member status.

TABLE 8 CERAMIC PROPERTIES — CABOT HEAD SHALE.

SAMPLE DESCRIPTION:

62-415: Ice Lake, Manitoulin Island; roadside (Highway 540) sample of weathered red shale.
62-417: Cataract Junction; lower 7 feet (2 m) of shale at the southwest end of the lower C.P.R. bridge.
62-418: Cataract Junction; middle 11 feet (3 m) of shale starting 13 feet (4 m) above the track at the north end of the bridge.
62-419: Cataract Junction; top 7 feet (2 m) of shale (Grimsby facies) at the same location.
62-419A: Cataract Junction; composite of the shale section at Cataract Junction.
63-425: DeCew Falls; 5 feet (1.5 m) of grey-green shale (Power Glen facies) from a section free of hard layers near the base.
63-426: DeCew Falls; 11 foot (3 m) section of red-brown shale (Grimsby facies).
63-431: Acton, lot 23, con.III, Esquesing Tp.; bottom 10 feet (3 m) of 41-foot (12.5 m) Cabot Head Shale drillcore section.
63-432: Acton, lot 23, con.III, Esquesing Tp.; next 10 feet (3 m) of 41-foot (12.5 m) Cabot Head Shale drillcore section.
63-433: Acton, lot 23, con.III, Esquesing Tp.; next 10 feet (3 m) of 41-foot (12.5 m) Cabot Head Shale drillcore section.
64-434: Acton, lot 23, con.III, Esquesing Tp.; top 11 feet (3 m) of 41-foot (12.5 m) Cabot Head Shale drillcore section.
64-435: Acton, lot 23, con.III, Esquesing Tp.; composite of the drillcore shale section.
64-436: Acton, lot 12, con.III, Esquesing Tp.; 4.5 feet (1.4 m) of green-grey shale (Thorold facies), drillcore sample.

CERAMIC PROPERTIES:

				Fired characteristics								
						% water Absorption						
Sample	% Water of plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	24-hr. cold	5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-415	26	4.5	3-4	010	4.7	9.1	9.6	2.04	Salmon	Very hard	Smooth-textured attractive briquettes at cones 010 & 06; bloated & over-fired at cone 03.
				06	8.9	0.4	0.6	2.35	Dark Red	Very hard	
				03	+1.0	0.3	11.3	1.62	Red Brown	Very hard	
62-417	26	4.6	5	010	1.6	15.6	16.5	1.82	Salmon	Hard	Briquettes marked by slight scum.
				06	6.1	6.2	6.5	2.07	Salmon-pink	Very hard	
				03	7.7	0.9	1.2	2.17	Brown	Very hard	
62-418	24	4.6	6-7	010	0.7	14.0	15.3	1.84	Pale salmon	Almost hard	Slight scum.
				06	3.5	8.4	10.6	2.01	Dark salmon	Hard	
				03	6.8	1.3	1.7	2.26	Red-Brown	Very hard	
62-419	22	3.8	6-7	010	0.2	14.8	17.3	1.80	Salmon	Almost hard	Slight scum.
				06	2.1	10.7	14.0	1.91	Dark salmon	Hard	
				03	5.2	5.1	7.8	2.05	Red-brown	Very hard	
63-425	15	1.9	5-6	010	+0.7	13.2	15.9	1.90	Tan	Soft	Low plasticity; coarse textured; abundant white scum.
				06	+0.3	12.3	14.5	1.93	Tan-Pink	Hard	
				03	0.3	11.3	13.3	1.95	Pink-Brown	Hard	
63-426	17	2.3	9-10	010	+0.5	11.0	13.4	1.98	Dark Pink	Almost hard	Slight scum.
				06	2.0	7.8	10.2	2.12	Red	Hard	
				03	3.2	4.0	6.4	2.26	Dark Red	Very hard	
63-431	17	2.9	4	06	0.7	12.3	14.8	1.92	Pale salmon	Hard	White scum common; blistered at cone 03.
				03	2.1	6.7	9.8	1.96	Brown	Very hard	

Table 8 continued: CERAMIC PROPERTIES — CABOT HEAT SHALE.

				Fired Characteristics								
						% water Absorption						
	% Water of plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	24-hr. cold	5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
63-432	19	3.1	4	06	0.7	6.5	8.6	2.13	Salmon	Very hard	White scum common; blistered at cone 03.
				03	2.1	2.7	5.2	2.05	Red-brown	Very hard	
63-433	17	2.8	5-6	06	2.4	8.2	10.2	2.07	Salmon	Hard	White scum common; blistered at cone 03.
				03	2.4	4.0	6.2	2.08	Pink-brown	Very hard	
63-434	17	2.5	6-7	010	0	12.3	15.2	1.90	Tan	Almost hard	Blistered, slight scum, at cone 03.
				06	2.1	9.7	12.5	1.99	Salmon-pink	Almost hard	
				03	2.7	5.9	8.4	2.07	Red-Brown	Very hard	
63-436	17	2.7	5	010	+0.8	16.4	18.2	1.84	Tan	Rather soft	Abundant white scum.
				06	0	14.3	16.5	1.89	Salmon-brown	Almost hard	
				03	0.3	13.1	15.6	1.91	Medium brown	Hard	

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), 06 (1840°F), 03 (1980°F).
**A plus (+) sign indicates expansion.

Composition

Dolomite is present in Cabot Head Shale in moderate amount, contributing sufficient lime and magnesia to weaken the fired colour of the shale. Of the clay minerals, illite is abundant, and chlorite is present in moderate amount.

Ceramic Properties and Utilization

Fresh Cabot Head Shale has low plasticity. Weathering greatly improves its plasticity and firing properties. Shale weathered to a red loamy soil on Manitoulin Island is plastic, smooth-textured, and burns to a dense, salmon-coloured body at cone 010 (904°C; 1660°F).

The Power Glen Shale, even with hard layers removed, has very low plasticity and poor firing properties. The green Thorold Shale is likewise of low plasticity; it burns to a soft porous body with abundant white scum.

The results of ceramic testing of Cabot Head samples are given in Table 8. Other test results are shown by Keele (1924, p.25). Cabot Head Shale has not been used for brick or tile in Ontario, principally because of the scarcity of workable deposits.

Some sections of Cabot Head Shale show promise for production of coated expanded aggregate (Wilson 1963, p.25, 40-41).

Distribution and Occurrences

The outcrop belt of the Clinton and Cataract Groups is shown in Figure 3. The Cabot Head Shale outcrops mainly in the steep face of the Niagara Escarpment, so that its real extent in plan is narrow. It is almost everywhere covered by younger strata, and few exposures could long be worked before excessive amounts of rock overburden would have to be moved. The Cabot Head Formation is distinguished from other formations of the Cataract Group on the shale outcrop map of Manitoulin Island (Figure 4). See also Liberty (1972, Maps 2244-2249 inclusive).

Good sections may be observed in the valley of Forty Mile Creek at Grimsby; also at Stoney Creek, Hamilton, Clappison Corners, Limehouse, Credit Forks, Cataract, and Horning's Mills. Exposures are also present in the valley of Beaver River at Eugenia Falls, at Owen Sound, and at Cabot Head on the tip of the Bruce Peninsula.

Sections sampled by the writer are described below. The results of chemical, mineral and ceramic testing of the samples mentioned are shown in Tables 8 and 9. Other Cabot Head sections are described by Caley (1940, p.32-35), and Bolton (1957, p.83-106), and Liberty (1971, p.33-37).

Ice Lake, Manitoulin Island

The Cabot Head consists mainly of red shale on Manitoulin Island. A small outcrop occurs at roadside where highway No. 540 curves away from the west side of Ice Lake. About 1.5 m (5 feet) of soft, loamy, green-speckled red shale was exposed and sampled (sample 62-415). The deeply weathered shale has a low lime content, excellent plasticity, and burns to a smooth-textured, dense, attractive salmon-red body at cone 010 (904°C; 1660°F).

Cataract

A good section of Cabot Head Shale, as well as the upper beds of the Queenston Shale, is exposed in the banks of the Credit River south of Cataract. The Canadian Pacific Railway line from Orangeville branches at Cataract Junction, one line proceeding west out of the Credit valley, the other following down the valley to the south. On the west bank, 0.4 km (¼ mile) southwest of the old Cataract dam and mill, the Cabot Head Shale occupies the section between the two tracks. The lower track rests on Manitoulin Limestone and Whirlpool Sandstone, the upper track on the Fossil Hill Dolomite.

Sample 62-417 is a vertical channel sample of the lower 2 m (7 feet) of shale, exposed at the southwest end of the railway bridge that crosses a small tributary stream entering the Credit from the west. The shale is very soft, very thin bedded, blue-grey to green-grey, weathered to pale blue-grey, with some rusty jointing and several interbedded hard, grey-brown limy layers, and grey-green sandy layers.

Samples 62-418 and 62-419 are channel samples taken at the north end of the bridge.

TABLE 9 ANALYTICAL DATA — CABOT HEAD SHALE.

CHEMICAL ANALYSES:

	62-415 %	62-417 %	62-418 %	62-419 %	62-419A %	63-425 %	63-426 %	63-431 %	63-432 %	63-433 %	63-434 %	63-435 %	63-436 %
SiO_2	—	—	—	—	53.60	—	65.20	—	—	—	—	55.30	—
Al_2O_3	—	—	—	—	16.40	—	15.30	—	—	—	—	16.10	—
Fe_2O_3	8.20	5.34	5.11	5.77	5.58	4.19	7.73	5.03	5.96	5.71	5.40	5.65	5.53
CaO	2.43	4.70	3.13	4.29	3.92	3.25	0.52	5.77	3.37	3.33	2.22	3.38	5.46
MgO	—	—	—	—	4.76	—	1.98	—	—	—	—	5.05	—
Na_2O	—	—	—	—	0.42	—	0.45	—	—	—	—	0.42	—
K_2O	—	—	—	—	5.27	—	4.64	—	—	—	—	5.28	—
TiO_2	—	—	—	—	0.80	—	0.80	—	—	—	—	0.77	—
CO_2	—	—	—	—	5.66	—	0.52	—	—	—	—	5.00	—
H_2O^+	—	—	—	—	3.10	—	3.03	—	—	—	—	3.21	—
H_2O^-	—	—	—	—	0.68	—	0.66	—	—	—	—	0.64	—
SO_3	—	—	—	—	Nil	—	0.39	—	—	—	—	0.19	—
MnO	—	—	—	—	0.06	—	0.05	—	—	—	—	0.08	—
Total	—	—	—	—	100.30	—	101.30	—	—	—	—	101.10	—
Loss on ignition	7.82	11.03	7.79	9.39	8.86	6.60	3.97	11.87	9.46	9.01	6.10	10.43	10.47
Soluble salts	0.97	0.89	0.88	0.98	—	0.81	—	1.00	1.49	1.87	1.19	—	0.65

MINERAL ANALYSES:

	62-415 %	62-417 %	62-418 %	62-419 %	63-425 %	63-426 %	63-431 %	63-432 %	63-433 %	63-434 %	63-435 %	63-436 %
Non-clay minerals:												
Quartz	18	17	32	29	39	32	29	20	22	34	22	41
Calcite	1	ND	3	1	1	<0.5	ND	ND	ND	ND	ND	ND
Dolomite	3	11	6	7	8	<0.5	18	8	8	4	8	13
Soda-lime feldspar	<1	ND	<1	<1	1	<0.5	ND	1	<0.5	ND	<0.5	ND
Potash feldspar	<1	<1	<1	<1	1	<0.5	ND	1	<0.5	1	<0.5	ND
Clay minerals:												
Illite	A	A	A	A	A	A	A	A	A	A	A	A
Chlorite	C	B	B	C	B	B	B	B	B	B	B	B
Expanding mineral	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

(A = abundant; B = moderate; C = minor; ND = not detected).

*See Table 8 for sample description.

Sample 62-418 represents 3 m (11 feet) of shale taken from a point commencing 4 m (13 feet) above the track; stratigraphically this sample begins 1-2 m (3-6 feet) above the top of sample 62-417. The shale is soft, very thin-bedded with platy lamination, grey-green, and uniform except for occasional hard sandy and limy layers 0.6-15 cm (¼-6 inches) thick. Hard layers thicker than 1.2 cm (½ inch) were not included in the sample.

Sample 62-419 represents the top 2 m (7 feet), immediately underlying the buff-weathering Fossil Hill Dolomite. A 1.5 m (5 feet) interval between samples 62-418 and 62-419 was not sampled because of the frequency of hard red dolomitic sandstone layers. These are still fairly common in the top 2 m (7 feet), interlayered with red and green mottled shale; only the shale was sampled. The upper 4 m (12 feet) of the Cabot Head section represents the Grimsby (and Thorold?) facies.

DeCew Falls

One of the best Silurian sections exposed in the Niagara Escarpment is at DeCew Falls, 5 km (3 miles) south of St. Catharines. Samples were taken above the powerhouse at the Ontario Hydro development. The section is fully described by Bolton (1957, p.83-84). Here the Power Glen and Grimsby Formations are approximately equivalent to the Cabot Head Shale further north, though they differ compositionally and have inferior ceramic properties.

The Power Glen Shale rests directly on Whirlpool Sandstone and is 15 m (48 feet) thick at this point. It is thin and medium-bedded with a platy lamination, relatively soft, and grey-green in colour. Hard interlayers of limy and sandy character comprise 30 percent and are fairly evenly distributed throughout the section. Sample 63-425 is a 1.5 m (5 feet) vertical channel sample from a section practically free of hard layers 1.5 m (5 feet) above the base. Another such section a few feet below the top was not sampled.

Immediately above the Power Glen, the Grimsby Formation consists of 3.5 m (11 feet) of shale topped by 9.5 m (31 feet) of sandstone. Sample 63-426 represents the 3.5 m (11 feet) shale section. The shale is very thin-bedded with platy lamination, soft, red-brown mottled with green; the section contains several hard rusty-weathering sandstone layers.

Acton

The Cabot Head section of a drill core drilled in 1963 by Acton Quarries Limited on lot 23, concession III, Esquesing Township, Halton County, was made available for ceramic evaluation. The hole was collared in Amabel Dolomite on the crest of the Escarpment. It entered Cabot Head strata at a depth of 35.8 m (117.5 feet) and the underlying Manitoulin Formation at 54.7 m (179.5 feet). A generalized log of this section is shown opposite.

Sample 63-436 represents the Thorold facies at the top of the Cabot Head section. It consists of soft, very thin bedded, green grey shale and pale limy sandstone. Minor seams of pyrite are probably responsible for the abundance of white scum on test briquettes.

The Grimsby facies consists of interlayered red fossiliferous limestone and shale.

The main shale section is 12.5 m (41 feet) thick. It was divided into four equal samples; a complete chemical analysis was performed on a composite of the four. The section consists of dark grey, very thin bedded, fissile shale, with hard limy and sandy interbeds totalling about 20 percent.

The basal 2 m (8 feet) consists of interlayered shale and dolostone transitional into the Manitoulin Formation.

WINGFIELD SHALE

According to Bolton (1957, p.37): "This formation is a completely northern facies and although exposures are limited to a few localities it can be traced from Kemble on the Bruce Peninsula north and west onto Manitoulin Island. On the mainland it represents the thin, eastern, clastic equivalent of the thick dolostone formations that were deposited westward on Manitoulin Island and the northern peninsula of Michigan."

The Wingfield Formation consists of green-grey shales interbedded with dense green-brown dolostone. The formation rests on the Dyer Bay Dolomite and is overlain by the St. Edmund Dolomite. It has its maximum thickness of 11 m (36 feet) at Cabot Head on the Bruce Peninsula. No chemical, mineral, or ceramic data are available, but the shale is likely to be highly dolomitic and of little ceramic interest.

Formation	Lithology	Interval (feet below collar)	Thickness (feet)	Sample Number
Reynales	Buff dolostone			
Cabot Head (Thorold Facies)	Green-grey shale	117.5-122.0 (35.8-37.2 m)	4.5 (1.4 m)	63-436
Cabot Head (Grimsby Facies)	Red Limestone	122.0-130.5 (37.2-39.8 m)	8.5 (2.6 m)	
Cabot Head	Grey shale	130.5-171.5 (39.8-52.3 m) Composite sample 63-435	41.0 (12.5 m)	63-434 63-433 63-432 63-431
Cabot Head	Grey shale and dolostone	171.5-179.5 (52.3-54.7 m)	8.0 (2.4 m)	
Manitoulin	Grey dolostone			

TABLE 10 ANALYTICAL DATA — SALINA AND ROCHESTER SHALES.

SAMPLE DESCRIPTION:

62-423: Ayton, roadcut 400 feet south of the South Saugeen River; lower 15 foot Salina Shale section.
62-424: Ayton, roadcut 800 feet south of the river; upper 17 foot Salina Shale section.
63-427: DeCew Falls, Escarpment section above Ontario Hydro powerhouse; lower 15 foot Rochester Shale section.
63-428: DeCew Falls, Escarpment section above Ontario Hydro powerhouse; middle 14 foot Rochester Shale section.
63-429: DeCew Falls, Escarpment section above Ontario Hydro powerhouse, upper 13 foot Rochester Shale section.
63-429A: DeCew Falls, Escarpment section above Ontario Hydro powerhouse, composite of Rochester Shale section.

CHEMICAL ANALYSES:

	62-423 %	-424 %	63-427 %	-428 %	-429 %	-429A %
SiO_2	—	38.60	—	—	—	29.90
Al_2O_3	—	8.80	—	—	—	8.94
Fe_2O_3	6.47	2.95	3.31	2.78	2.14	2.55
CaO	21.00	13.30	19.10	23.80	29.00	22.30
MgO	—	11.30	—	—	—	5.80
Na_2O	—	0.37	—	—	—	0.40
K_2O	—	4.09	—	—	—	2.96
TiO_2	—	0.43	—	—	—	0.49
CO_2	—	18.94	—	—	—	23.50
H_2O^+	—	1.51	—	—	—	1.75
H_2O^-	—	0.55	—	—	—	0.65
SO_3	—	Nil	—	—	—	0.60
MnO	—	0.03	—	—	—	0.09
Total	—	100.90	—	—	—	99.90
Loss on ignition	27.13	21.84	24.17	25.05	28.29	25.91
Soluble salts	0.50	—	0.60	0.57	0.59	—

MINERAL ANALYSES:

	62-423 %	-424 %	63-427 %	-428 %	-429 %
Non-clay minerals:					
Quartz	27	27	16	14	12
Calcite	20	5	13	27	39
Dolomite	36	37	29	22	19
Soda-lime feldspar	< 1	< 1	< 0.5	< 0.5	< 0.5
Potash feldspar	2	ND	< 0.5	< 0.5	< 0.5
Clay minerals:					
Illite	C	B	A	A	B
Chlorite	C	C	C	C	C
Expanding mineral	ND	ND	C	—	—

(A = abundant; B = moderate; C = minor; ND = not detected).

CERAMIC PROPERTIES:

Sample	% Water of plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	Fired Characteristics: % water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-423	15	1.2		010							
				06	+4.0						Soft, chalky, and bloated briquettes easily disintegrated.
				03	+4.5	39.3	47.8	1.22	Cream	Very soft	
62-424	18	2.8	7	010	+1.0	29.0	31.8	1.51	Cream	Soft	Uniform, chalky, even textured.
				06	+2.2	29.8	33.0	1.47	Cream	Soft	
				03	+2.4	28.5	34.1	1.44	White	Soft	
63-427	15	2.5	5-6	010	+0.5				Tan	Soft	Briquettes fired at cone 010 disintegrated during absorption tests.
				06	+1.7	28.9	31.7	1.52	Cream-grey	Mod.hard	
				03	0.8	28.0	32.7	1.49	Cream	Mod.hard	
63-428	16	2.8	5-6	010	+1.9				Tan-grey	Soft	Soft chalky briquettes easily disintegrated.
				06	+3.1	30.2	34.5	1.44	Cream-grey	Rather soft	
				03	+3.6	29.2	35.2	1.42	Cream	Mod.hard	
63-429	15	2.9	10-11	010	+2.4				Pale grey	Very soft	Soft chalky briquettes easily disintegrated.
				06	+4.8	39.2	43.6	1.30	Cream-grey	Very soft	
				03	+5.2	37.9	43.9	1.28	Cream	Very soft	

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), 06 (1840°F), 03 (1980°F).
**A plus (+) sign indicates expansion.

More recent studies by Liberty and Bolton (1971, p.33-37) include the Wingfield as a member of an expanded Cabot Head Formation, although it is stratigraphically distinct from typical Cabot Head Shale.

NEAHGA SHALE

The Neahga Formation is so thin in Ontario as to be of no economic importance. It is 1.5-2 m (5-6 feet) thick in the Niagara gorge and pinches out about 30 km (20 miles) to the west. It consists of dark grey to green platy shale with minor grey limestone. Neahga Shale overlies the Thorold Sandstone and underlies the Reynales Dolomite. It is described by Bolton (1957, p.24-25). The writer knows of no chemical, mineral, or ceramic testwork for the Neahga Shale, but because of the interlayered limestone the shale also is likely to be limy.

ROCHESTER SHALE

Shale of the Rochester Formation is restricted in Ontario to the southern part of the Escarpment from Waterdown to Niagara. It is a dark grey limy shale interlayered with many hard limestone beds. Rochester Shale forms part of the Clinton Group of Middle Silurian age. The shale has little ceramic value; it is highly calcareous, low in plasticity, and burns to a weak, chalky, soft body.

Geology

The Rochester Formation consists of dark grey, soft to moderately hard, thin and very thin-bedded, fossiliferous limy shale, interlayered with a moderate number of hard grey-brown limestone beds. Brachiopod and Bryozoan fossils are particularly common in lenticular sandy or limy pockets. The proportion of hard layers increases progressively towards the top. The shale formation grades laterally into a thin limestone-dolostone facies north of Waterdown. Maximum thickness of the formation in Ontario is 18 m (58 feet) at Niagara Falls; it thins westward and northward.

Rochester Shale makes a sharp contact with the underlying buff-coloured Irondequoit Limestone. The upper contact with the DeCew Dolomite is less distinct because of the upward increase in shaly limestone. The Rochester Formation is described by Bolton (1957, p.29-32).

Composition

Calcite and dolomite comprise about 50 percent of the Rochester Shale. While dolomite decreases relatively, calcite increases progressively towards the top of the formation, much of it in the form of discreet limestone interbeds. Illite is the predominant clay mineral, with minor amounts of chlorite. Chemical composition of three samples from DeCew Falls is given in Table 10.

Ceramic Properties and Utilization

Rochester Shale has little to recommend it as a ceramic material. It is highly calcareous, very low in plasticity, and bloats on firing to a weak, soft, porous, cream-coloured body. Ceramic properties of three samples from the section at DeCew Falls are shown in Table 10.

Rochester Shale exhibits moderate bloating characteristics but only at the agglomerating temperature, making it unsatisfactory for coated aggregate production in the rotary kiln (Wilson 1963, p.38-39).

Distribution and Occurrences

Rochester Shale is restricted to the Niagara Escarpment south of Waterdown. Exposures are seen in the Niagara gorge, DeCew Falls, the upper falls at Rockway (Fifteen Mile Creek), the Grimsby gorge, Stoney Creek gorge, and Albion Falls.

SALINA SHALE

Grey dolomitic shale of the Salina Formation is exposed near Walkerton and Hanover in Grey and Bruce counties and at Fort Erie

on the Niagara River. The Salina is principally known as the source for salt and gypsum in southwestern Ontario. Dolostone is most typical of the formation along its outcrop belt, and the associated dolomitic shales have little value for ceramic products. Formerly referred to as Camillus Shale, the Salina Formation is Upper Silurian in age.

Geology

The Salina Formation has been divided into seven lithological units (Grieve 1955) designated A to G in ascending order. The formation has its maximum thickness in Michigan, the centre of a major basin of deposition during the Silurian, and it thins outwards towards the rim. Near its outcrop belt in west central Ontario units B and D, which are almost entirely salt, are absent; units A-2 and G may also be absent or greatly reduced in thickness (Guillet 1964, p.14-16). Unit C is the principal shaly unit; it consists of interlayered brown shaly dolostone and dolomitic green-grey shale. Thin beds of gypsum are scarce in this unit. The Salina Formation varies in thickness from about 110 m (350 feet) at its outcrop belt to nearly 460 m (1,500 feet) at Sarnia; the top of the formation is about 365 m (1,200 feet) below the surface at Sarnia.

The contact of the Salina with the underlying Guelph-Lockport-Amabel dolostones is difficult to define, and is usually placed just below the last bed of anhydrite in the Salina. The upper contact with the Bass Island Dolomite is also indefinite, and is placed where gypsum and anhydrite is no longer found in the shaly dolostones.

Composition

The Salina Formation contains no pure dolostone or shale but mixtures of both in all proportions. Compositions of the shale beds are therefore both dolomitic and variable. Non-clay minerals comprise three-quarters of the mineral composition of the shale. Dolomite predominates, comprising one-third of the shale section sampled. Total carbonate content is about half the sample, and quartz comprises about one-quarter. Illite and chlorite make up the small clay fraction. Gypsum may also be an undesirable constituent of some shale sections, though it occurs in discreet beds rather than diffused through the shale itself. Chemical and mineral analyses of samples from Ayton, near Walkerton, are given in Table 10.

Ceramic Properties and Utilization

Salina Shale has no ceramic value. It exhibits very low plasticity, and expands on firing to a soft, porous, weak, chalky body. Results of ceramic tests on samples from the Walkerton area are shown in Table 10.

Bloating tests on a small sample from Fort Erie were unsatisfactory for expanded aggregate (Wilson 1963, p.38).

Distribution and Occurrences

The Salina outcrop belt is shown in Figure 4. Drift cover is fairly heavy however, and exposures are few. Keele (1924, p.26) mentions briefly the known occurrences. The shale may be seen in the Niagara River bank just north of the International Bridge at Fort Erie, and in the bank of the South Saugeen River between Ayton and Neustadt in Normanby Township, Grey County. A roadcut exposure in the latter area was examined and sampled.

MARCELLUS SHALE

Black bituminous shale of the Marcellus Formation is not exposed in Ontario but has been intersected in oil and gas wells near Lake Erie in Norfolk and Elgin counties. The maximum recorded thickness is 9 m (30 feet) in a well at Port Stanley (Winder 1961, p.75); drift cover in the area is several hundred feet thick. In Ontario the Marcellus underlies the glacial drift and grades downwards into Delaware Limestone. The shale is Middle Devonian in age and underlies the Hamilton Formation in New York state. No data is available on its chemical and ceramic quality.

HAMILTON SHALE

Soft blue-grey shale of the Hamilton Formation of Middle Devonian age has been used for making brick and tile at Parkhill and Thedford respectively. The formation consists of both limestone and shale, and is divided lithologically into four members. Shale of the Petrolia Member is soft, easily weathered, highly plastic, and burns to a dense, hard, red-brown body over a moderate firing range. The shale underlies parts of Elgin, Middlesex, Lambton, Kent, and Essex counties (Figure 3).

Geology

The Hamilton Formation consists of four members in ascending order: Olentangy Shale, Widder Beds, Petrolia Shale, and Ipperwash Limestone. Both the Olentangy and Petrolia members are predominantly soft, pale blue-grey, more or less limy shale; they vary in thickness 8-30 m (25-100 feet) and 20-58 m (70-190 feet) respectively. The Widder and Ipperwash members consist of interlayered soft shaly limestone and hard, fine-crystalline limestone. Combined thickness for the Hamilton Formation is 75-90 m (250-300 feet). Fossils are locally abundant.

The Hamilton Formation has a sharp contact with the overlying Dundee Limestone and underlies bituminous shale of the Kettle Point Formation. A more complete description of the Hamilton Shale is contained in a previous report (Guillet 1967, p.103-111).

Compostion

Typical sections of Hamilton Shale (Petrolia Member) are not excessively limy; they contain a near balance of lime and iron. The shale contains a higher proportion of clay minerals than in most Ontario shales; illite and chlorite are both abundant, and together constitute about two-thirds of the rock. Soluble salts diffused through the shale are also common, and will cause scumming of efflorescence on fired products unless rendered insoluble by barium carbonate. The average chemical and mineral composition of four samples from two quarries is given in Table 11. More detailed results of the sampling in the quarries at Thedford and Arkona are given by Guillet (1967, p.103-111). Other analytical work is reported by Keele (1924, p.27) and Brady and Dean (1965, p.18,20, and 33A).

Ceramic Properties and Utilization

Hamilton Shale is soft, readily broken down by weathering, and smooth and very plastic when wet. It has a moderately good firing range, and burns to a dense, weak red or red-brown body, marked only by rather heavy scumming. The shale was formerly used for brick and tile at Parkhill and Thedford respectively. Shale for the Parkhill plant was obtained from a small quarry at Arkona.

Average ceramic properties of the Arkona and Thedford shales, as used at Parkhill and Thedford respectively, are shown in Table 11. More detailed results are given in a previous report (Guillet 1967, p.103-111). Other ceramic testwork is reported by Keele (1924, p.27) and Brady and Dean (1965, p.12-13, 41-43).

Some sections of Hamilton Shale performed well in rotary kiln tests for coated aggregate (Wilson 1963, p.28).

Distribution and Occurrences

The outcrop areas of the Hamilton Formation are shown in Figure 4. It is the bedrock for the western part of Elgin and Middlesex counties, and parts of Lambton, Kent, and Essex counties. Exposures of the shale are scarce and restricted to the northeast part of the outcrop area, where small quarries have been opened near Arkona on the Ausable River, and at Thedford. Shale is also exposed in a railway cut 1.6 km (1 mile) east of Thedford station, at Stoney Point on Lake Huron, and Smiths Falls on the Sydenham River.

KETTLE POINT SHALE

The Kettle Point Formation underlies The Port Lambton Shale in southwestern Ontario, and is also Upper Devonian in age. It consists of brittle, brown or black, bituminous

shale containing large spherical carbonate concretions. Kettle Point Shale is the bedrock for most of Lambton and Kent counties (Figure 3), but exposures are few because of the heavy cover of glacial drift. The shale is sometimes also known by the name "Huron".

Kettle Point Shale has little ceramic value; it has low plasticity, and it burns to a soft, weak, porous red body with abundant scum.

Geology

Kettle Point Shale is a black, brown-weathering, brittle, thin-bedded rock with platy lamination. Rusty alteration in brown, yellow, red, and green is common on exposed sections. Spherical calcite concretions up to 1 m (4 feet) in diameter occur at about 15 m (50 feet) intervals laterally but are peculiar only to the lowermost beds (Winder 1961, p.66). These "kettles" are characterized by a distinct internal radiating structure, light-coloured near the centre and becoming dark brown-grey at the rim. Shale bedding does not pass into the concretion but is displaced around it above and below. Pyrite or marcasite is also common in the shale, occurring sometimes as concretions 2.5-5 cm (1-2 inches) in diameter. The Kettle Point Formation is known to exceed 90 m (300 feet) in thickness but is usually much less.

The contact with underlying Hamilton Shale is fairly sharp, and marked in some places by a zone of green shale included in the Kettle Point (Caley 1943, p.62). The upper contact with the grey Port Lambton Shale is sharp.

Composition

Kettle Point Shale is a brittle, non-calcareous, bituminous rock. It has a high content of organic material and pyrite, both of which contribute to poor firing characteristics. Except for the "kettle" concretions, calcite and dolomite are practically absent. A partial chemical analysis and a mineral analysis of a sample from the type area, Kettle Point on Lake Huron, is shown in Table 11. A complete chemical analysis and a mineral analysis is also given by Brady and Dean (1965, p.18 and 20).

Ceramic Properties and Utilization

Kettle Point Shale has the lowest lime content of any of the Paleozoic shales in Ontario, a fact that at first would encourage speculation as to its ceramic value. However, its high organic and sulphur content has rendered the shale brittle, and has given the burned ware excessive yellow scum and difficult firing behaviour. The shale is more refractory than most Ontario shales, and it vitrifies with difficulty above cone 03 (1980°F). Below this temperature the burned ware is soft, weak and porous, but except for scum is of good red colour. The results of ceramic testing of a single sample are given in Table 11. Brady and Dean (1965, p.13) show the results of firing tests to cone 1 (1136°C; 2077°F). The shale has not been used for ceramic products in Ontario.

Wilson (1963, p.28) states that the shale does not bloat below its fusion temperature, and hence shows little value for expanded aggregate.

Distribution and Occurrences

Kettle Point Shale is the bedrock for most of Lambton and Kent counties as shown in Figure 3. However, because of a heavy cover of glacial drift there are few exposures. The best known is at Kettle Point on Lake Huron, from which the formation derives its name. Other exposures are confined to river banks: on Bear Creek near Kingscourt; on Sydenham River at Alvinston, Shetland, and Croton (Keele 1924, p.28).

PORT LAMBTON SHALE

The Port Lambton Formation consists of soft, pale grey, fissile shale interlayered with siltstone and overlain by very fine-grained grey sandstone. The formation is the bedrock for a small area (Figure 3) adjacent to the St. Clair River in Moore and Sombra townships, Lambton County. It is everywhere covered by glacial drift and there are no exposures; the formation is only known from well data. Thicknesses of up to 60 m (200 feet) have been recorded (Winder 1961, p.89). The formation is the youngest in the Paleozoic sequence of southern Ontario,

Photo 3 – Kettle Point Shale at Kettle Point, Lake Huron.

TABLE 11 ANALYTICAL DATA – KETTLE POINT AND HAMILTON SHALES.

SAMPLE DESCRIPTION:

62-416: **Kettle Point:** 9-foot section (minus concretions) on Lake Huron shore.
Hamilton Shale: Quarries at Thedford and Arkona; average of four samples (Guillet 1967, p.104).

CHEMICAL ANALYSES:

	Kettle Point Shale Sample 62-416 Percent	Hamilton Shale Average Percent
SiO_2	–	51.64
Al_2O_3	–	16.90
Fe_2O_3	5.80	6.37
CaO	0.56	6.55
MgO	–	2.39
Na_2O	–	0.22
K_2O	–	3.85
TiO_2	–	0.88
CO_2	–	5.63
H_2O^+	–	3.91
H_2O^-	–	0.60
SO_3	–	0.62
Total	–	99.60
Loss on ignition	15.68	9.70
Soluble salts	2.05	–

MINERAL ANALYSES:

	Kettle Point Shale Sample 62-416 Percent	Hamilton Shale Average Percent
Non-clay minerals:		
Quartz	33	26
Calcite	<1	10
Dolomite	ND	0.2
Soda-lime feldspar	1	0.2
Potash feldspar	ND	0.2
Clay minerals:		
Illite	A	A
Chlorite	B	A
Expanding minerals	ND	ND

(A = abundant; B = moderate; ND = not detected).

CERAMIC PROPERTIES:

Sample	% Water of plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage	Fired Characteristics: % water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
Kettle Point 62-416	17	0.8	12-13	010	0.0	27.1	33.7	1.41	Salmon	Very soft	Coarse-textured, weak, abundant yellow scum.
				06	1.7	24.7	31.2	1.46	Salmon-red	Soft	
				03	5.2	17.1	23.1	1.63	Dark red	Soft	
Hamilton Shale (Average)	25	4.4	5	010	0.0	15.6	16.0	1.77	Pale brown	Almost hard	Abundant white scum.
				06	2.1	10.1	11.3	1.90	Red-brown	Hard	
				03	3.3	6.5	7.2	2.00	Dark brown	Very hard	

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), 06 (1840°F), 03 (1980°F).

and is Upper Devonian in age. No analytical or ceramic data is available.

Ottawa Area

ROCKCLIFFE SHALE

Thick beds of grey-green shale, containing lenses of fine grey sandstone, constitute the Rockcliffe Formation, an Ordovician shale restricted to the Ottawa area (Figure 6). It fires to a poorly-vitrified brown body of doubtful value for heavy clay products.

Geology

The Rockcliffe Formation consists of friable olive-green shales and lenses of grey or red sandstone. Some of the sandstone lenses are sparsely fossiliferous. Thickness of the formation is 40-48 m (140-160 feet). It makes sharp contact with the underlying Oxford Dolomite, but grades upwards into the St. Martin Limestone. The Rockcliffe Formation is described by Wilson (1946, p.17-19).

Composition

Rockcliffe Shale is brittle and sandy; quartz and potash feldspar are present in more than usual amount. Chemical composition as given by Brady and Dean (1966, p.32) is reproduced in Table 12.

Ceramic Properties and Utilization

A sample of Rockcliffe Shale was tested by Brady and Dean (1966, p.27) with poor results. Plasticity is too low for extrusion equipment, and it fires to a porous brown body of moderate hardness. The test briquettes showed moderate scumming. Shrinkage was low, but water absorption was 12-14 percent at optimum firing temperatures. Its value for expanded aggregate production has not been determined.

Distribution and Occurrences

Rockcliffe Shale was named for its prominent occurrence at Rockcliffe Park in east Ottawa, where it is exposed in high cliffs along the Ottawa River. It is exposed intermittently for some miles both above and below Ottawa. Outcrops are also known near Winchester, Morrisburg, Cornwall, and Hawkesbury (see Figure 6), but the formation is restricted to the lowland east of the Frontenac Axis.

Rockcliffe Park

An exposure of the shale in the south bank of the Ottawa River at Rockcliffe Park in east Ottawa was tested by Brady and Dean (1966, p.32).

Thunder Bay Area

ANIMIKIE SHALE

The oldest shale that has been used for structural clay products in Ontario is the Animikie Shale of the Lakehead region, northwestern Ontario. It is a brittle shale, grading in places to slate, that was deposited in a late Precambrian (Lower Proterozoic) sea 1.6 billion years ago.

Geology

Rocks of the Animikie Group are divided into three formations: The Kakabeka Conglomerate is the thin basal formation. It is overlain by the Gunflint Formation consisting of taconite (iron formation), carbonate rock, and some shale. The Rover Formation overlies the Gunflint and consists largely of shale; it is known to exceed 360 m (1,200 feet) in thickness. Animikie rocks are flat-lying on a peneplaned surface of Early Precambrian granite and older basement rocks.

Shales of the Rove Formation are grey-black, medium to very thin-bedded, fissile weathering, brittle rocks, interbedded in some places with layers of siltstone and greywacke. The shales weather to medium grey, except in the upper few feet of outcropping sections

TABLE 13 ANALYTICAL DATA — ANIMIKIE SHALE.

SAMPLE DESCRIPTION:

62-404: One mile north of Middle Falls, west side No. 61 Highway; 20 feet of grey-black shale.
62-405: Location as above; 5 feet of buff-weathered shale.
62-406: Riverdale Road quarry; 10 feet of blue-black shale.
62-407: Oliver Road quarry; 4 feet of hard rusty shale.
62-408: Sibley Peninsula Road; 2.2 miles south of No. 17 Highway; lower 10.5 feet of shale.
62-409: Location as above; upper 9 feet of shale.
62-409A: Location as above; composite of samples 62-408 and 62-409.

CHEMICAL ANALYSES:

	62-404 %	-405 %	-406 %	-407 %	-408 %	-409 %	-409A %
SiO_2	—	—	—	—	—	—	60.70
Al_2O_3	—	—	—	—	—	—	15.70
Fe_2O_3	7.49	8.05	4.07	23.40	5.50	5.46	5.84
CaO	0.55	0.42	0.90	0.90	0.90	0.57	0.68
MgO	—	—	—	—	—	—	2.72
Na_2O	—	—	—	—	—	—	1.52
K_2O	—	—	—	—	—	—	3.70
TiO_2	—	—	—	—	—	—	0.74
CO_2	—	—	—	—	—	—	1.42
H_2O^+	—	—	—	—	—	—	3.38
H_2O^-	—	—	—	—	—	—	0.82
SO_3	—	—	—	—	—	—	1.51
MnO	—	—	—	—	—	—	0.03
Total	—	—	—	—	—	—	98.80
Soluble salts	0.73	0.92	0.60	0.94	1.06	0.63	—
Loss on ignition	4.18	5.04	6.17	7.84	7.93	7.23	7.29

MINERAL ANALYSES:

	62-404 %	-405 %	-406 %	-407 %	-408 %	-409 %
Non-clay minerals:						
Quartz	30	33	27	43	30	31
Calcite	ND	ND	ND	ND	ND	ND
Dolomite	2	1	1	3	1	1
Soda-lime feldspar	4	3	3	ND	2	3
Potash feldspar	ND	ND	1	ND	1	1
Clay minerals:						
Illite	A	A	A	ND	A	A
Chlorite	B	B	C	ND	B	B
Expanding mineral	B	C	A[1]	C[2]	C[1]	C[1]

[1] Interlayered mineral
[2] Unidentified layered mineral
(A = abundant; B = moderate; C = minor; ND = not detected).

CERAMIC PROPERTIES:

Fired Characteristics

Sample	% Water of plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	% water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-404	14	1.5	7-8	010	+0.3	13.7	17.0	1.90	Salmon	Rather soft	Green briquettes are inclined to be flabby. Fired briquettes are marked by slight scum.
				06	0.0	10.4	13.8	1.96	Dark salmon	Almost hard	
				03	2.9	4.5	7.8	2.12	Dark red	Very hard	
62-405	16	1.5	7-8	010	0.0	11.2	13.1	2.01	Salmon	Hard	Briquettes fired to cone 010 are attractive; slightly blistered at cone 03.
				06	1.4	8.3	10.6	2.11	Salmon-red	Hard	
				03	5.4	1.6	3.8	2.36	Dark red	Very hard	
62-406	15	2.5	5-6	010	+0.3	13.1	15.8	1.87	Pale Salmon	Rather Soft	Briquettes fired to cone 03 exhibit slight blistering and scum.
				06	0.5	10.8	13.4	1.95	Salmon	Hard	
				03	3.2	1.9	4.7	2.10	Dark red	Very hard	

Table 13 continued: ANALYTICAL DATA – ANIMIKIE SHALE.

				Fired Characteristics							
						% water Absorption					
	% Water of plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	24-hr. cold	5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-407	low			010		18.0			Salmon-brown	Very soft	Crushed shale is brittle; low plasticity. Briquettes are poorly consolidated; readily disintegrated.
				06		20.3	24.3	1.64	Salmon-red	Very soft	
				03		19.7	25.0	1.64	Red	Very soft	
62-408	16	1.6	7	010	+0.5	17.8	22.7	1.66	Pale salmon	Soft	Sandy-textured; low plasticity.
				06	0.3	16.8	22.2	1.68	Salmon-pink	Almost hard	
				03	3.2	8.6	13.5	1.87	Pale red	Hard	
62-409	16		7	010		14.7	17.7	1.82	Pale salmon	Almost hard	Coarse Textured; moderately consolidated.
				06		12.8	15.6	1.89	Salmon	Almost hard	
				03		4.0	7.0	2.13	Salmon-red	Very hard	

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), cone 06 (1840°F), cone 03 (1980°F).
**A plus (+) sign indicates expansion.

TABLE 12 CHEMICAL ANALYSIS* – ROCKCLIFFE SHALE.

	PERCENT
SiO_2	61.17
Al_2O_3	12.76
FeO	2.38
Fe_2O_3	1.07
TiO_2	0.66
CaO	6.52
MgO	0.89
Na_2O	0.81
K_2O	4.67
Ignition loss	8.74
Total	99.67

*After Brady and Dean (1966, p.32).

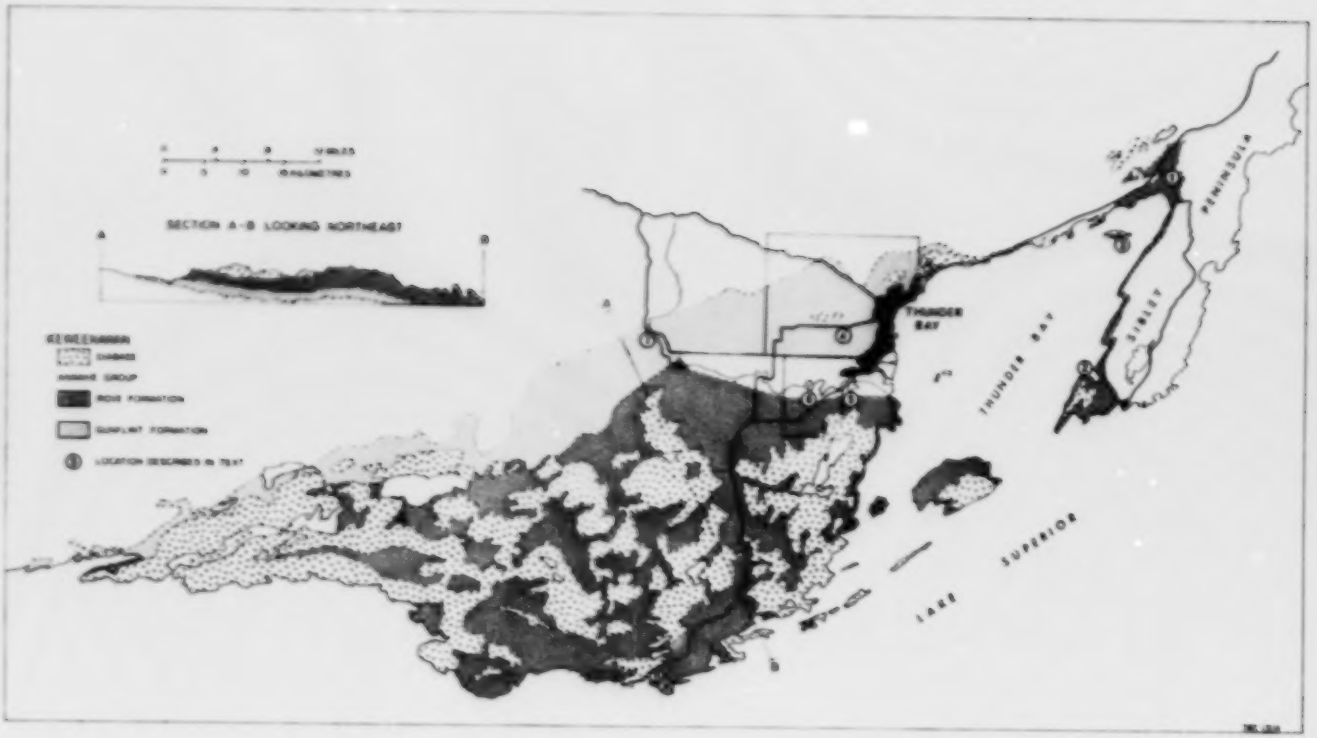


Figure 7 – Animikie Shales in the Thunder Bay region.

where they are oxidized to yellow-buff. Flattened spheroidal concretions up to 2 m (8 feet) in diameter and 1 m (4 feet) thick are locally common in the Rove Shale. They are composed mainly of calcium carbonate, apparently leached from limy layers in the shale, and have formed since the deposition of the shale, distorting the bedding both above and below. Concretions in the Rove sediments are the subject of a paper by Moorhouse (1963). Narrow dikes and sills of brown-weathering diabase cut all Animikie rocks.

Composition

Animikie Shales are sandy non-calcareous rocks. Quartz constitutes one-third of the average sample, and dolomite is a very minor constituent. Iron ranges between 5-8 percent (Fe_2O_3), except in the siliceous iron-rich varieties more properly called taconites. Of the clay minerals, illite is abundant and chlorite occurs in moderate amount. Animikie rocks also contain various layered minerals structurally related to the clays. Chemical and mineral composition of a number of samples are detailed in Table 13.

Ceramic Properties and Utilization

Shales of the Animikie Group are rather brittle; when ground and moistened they exhibit plasticity too low for auger extrusion equipment. Keele (1924, p.133-134) however, states that shale from some sections, notably at Sawyer Bay on the west side of Sibley Peninsula, is sufficiently plastic for extruded ware, while more slaty materials have been used for dry-pressed brick. The results of ceramic tests on various samples of Animikie Shale are shown in Table 13. The shale burns red with a short vitrification range, giving a body of moderate hardness and absorption. Fine-grinding of the shale is important for improved plasticity and texture. Without the addition of a plastic clay the briquettes are weak and gritty-textured in both the fired and unfired states. Traces of white scum were noted in a few cases.

There are only two recorded attempts at commercial utilization of Animikie Shale. A plant was operated at the base of Mount McKay for a short period, making dry-pressed brick from the hard gritty shales of this locality (Keele 1920, p.107). Shale from Sawyer Bay on the west side of Sibley Peninsula was briefly used for dry-pressed brick at the Alsip plant at Fort William (Keele 1924, p.11).

Distribution and Occurrences

Pye (1962, p.13) states that the Animikie Shale "is found in a number of localities between Pigeon River and Loon Lake, along or close to highways No. 61 and No. 17-11; it can be studied most conveniently at Middle Falls, High Falls, and Riverdale Road quarry, Mount McKay, and on Sibley Peninsula". Geological maps showing the outcrop areas for Animikie rocks in the northern part of this region accompany the report by Tanton (1931, maps 276A and 1902). Some of the more accessible outcrops are described in the following notes and indicated by number on Figure 7. See also ODM compilation maps 2065 and 2232.

Sibley Peninsula, Roadside Quarry (1)

An abandoned quarry on the east side of Highway 587, 3.5 km (2.2 miles) south of Highway 17-11, exposes a 6 m (20 feet) face of Rove Shale over a length of 90 m (300 feet). The section is topped by several feet of weathered shale topsoil containing a few stones. The top extends eastward in a level plane, making this an excellent quarry location.

The lower 3 m (10.5 feet) is a uniform grey-black, moderately hard, medium-bedded, shale that weathers with a fissile lamination and a medium-grey colour. White efflorescence is common; also some rusty weathering. Large orange-brown carbonate concretions occur at intervals of 3-6 m (10-20 feet) at two horizons. Concretions of the upper horizon, 2 m (7 feet) above the floor, are associated with a continuous 7.5 cm (3 inches) limy layer. Sample 62-408 is a vertical channel sample of the 3 m (10.5 feet) section, disregarding the concretions and hard limy bed.

The upper 3 m (9 feet) of the quarry section contains no concretions or hard layers. It is softer due to weathering, and is oxidized to a pale-grey colour. Efflorescence and rusting

is present in moderate amount. Sample 62-409 is a vertical channel sample of the 3 m (9 feet) section.

Jointing is moderately well developed in the shale in two directions, north-south and east-west.

Sibley Peninsula, Sawyer Bay (2)

Keele (1924, p.11 and p.133-134) reports on Rove Shale that forms the western shore of Sibley Peninsula. Some shale was mined at Sawyer Bay and taken by barge to the Alsip plant at Fort William, where it was made into dry-pressed brick.

Shale banks along the shore reach a thickness of 12 m (40 feet) in some places. A large sample tested at the Mines Branch, Ottawa, was found satisfactory for brick and structural tile, although its plasticity was rather low and firing range short.

Keshkabuon (Caribou) Island (3)

Keele (1924, p.12) states that Caribou Island is a good source of Animikie Shale. A 9 m (30 feet) section of shale is exposed, overlain by a great thickness of other rocks. Much shale is available in exposed sections and talus slopes free of overburden. Caribou Island lies 1.6 km (1 mile) offshore, 26 km (16 miles) east of the city of Thunder Bay.

Oliver Road Quarry (4)

Workings cover a wide area on both sides of Oliver Road (Highway 130) in a shallow quarry 5 km (3 miles) west of Thunder Bay. A section 0.9-1.2 m (3-4 feet) thick of hard iron-bearing shale of the Gunflint Formation is overlain by 0.9-2.4 m (3-8 feet) of brown sandy soil. The shale is a rusty, grey-black, brittle rock with platy lamination. A small bulk sample, 62-407, was analysed for its chemical and mineral composition and its ceramic properties. The quarry is worked for road material; the shale has little or no value for heavy clay products.

Mount McKay (5)

Mount McKay is a large mesa of interbedded shale and greywacke of the Rove Formation located on the south side of the city of Thunder Bay. The Rove sediments are capped by a flat-lying sill of diabase, 60 m (200 feet) thick, and a 4.5 m (15 feet) sill of diabase is interlayered with the shales 120 m (400 feet) below the top. Total exposed thickness of the shales and greywackes is about 240 m (800 feet). Keele (1924, p.134) states that a plant was built at the base of Mount McKay to produce dry-pressed brick, but the hard brittle shale was not extensively used.

Riverdale Road Quarry (6)

Rove Shale is exposed in a quarry on Riverdale Road, 1.2 km (3/4 mile) north of Highway 61 and about 5 km (3 miles) southwest of Thunder Bay. A 3 m (10 feet) section of the shale is exposed over a length of 90 m (300 feet). The section exposes a medium-bedded, blue-black shale, that weathers with a platy lamination and a blue-grey colour. White efflorescence and rusty alterations are common. Large carbonate concretions occur at intervals of 3-5 m (10-15 feet) at a single horizon 2 m (6 feet) above the floor. Vertical jointing is well-developed at N40°W and N55°E. The results of chemical, mineralogical, and ceramic testing of a 3 m (10 feet) vertical channel sample, 62-406, is given in Table 13; concretions were not included in the sample.

Concretions in the Riverdale Road quarry are briefly described by Pye (1962, p.22-23). Moorhouse (1963) deals at some length with concretions occurring in the nearby valley of the Slate River.

Kakabeka Falls (7)

Black thin-bedded shale of the Gunflint Formation comprises most of the 38 m (125 feet) section of rock exposed in the gorge of the Kaministikwia River below Kakabeka Falls. The Falls are located close to Highway 17-11 about 30 km (18 miles) west of Thunder Bay. The shales are protected by a 0.6 m (2 feet)

capping of Gunflint chert-carbonate rock that forms the lip of the falls.

Middle Falls (8)

On the west side of Highway 61, across from Middle Falls, is a 15 m (50 feet) section of very thin-bedded, fissile weathering, Rove Shale capped by blocky, brown-weathering, diabase. A second diabase sill, about 1 m (4 feet) thick lies below the cap, and three dikes of diabase cut both the sills and shales. The exposure is described by Pye (1962, p.19-20). The occurrence is not a suitable quarry location.

A 9 m (30 feet) section of Rove Shale is exposed for 60 m (200 feet) along the west side of Highway 61 1.6 km (1 mile) north of Middle Falls. There is no diabase cap at this point, and the top slopes gradually upwards and away from the road, so that a reasonable amount of shale could be recovered before overburden became excessive. The section consists of very thin-bedded grey-blue shale with fissile weathering, interbedded with numerous hard siltstone layers to 5 cm (2 inches) thick. Two thin diabase dikes occupy a sheared zone at the north end of the exposure, and a 1 m (3 feet) brown-weathering dike cuts the shales near the centre. Several carbonate concretions 0.6-1 m (2-3 feet) in diameter are visible in the face. Samples 62-404 and 62-405 are vertical channel samples of the lower 6 m (20 feet) of grey-blue shale and 1.5 m (5 feet) of the top buff-weathered shale respectively.

High Falls (9)

A 30 m (90 feet) section, composed of interbedded shales and greywackes of the Rove Formation, is exposed in the walls of the Pigeon River gorge below High Falls. As at Middle Falls, 3 km (2 miles) upstream, a vertical diabase dike that cuts the softer sedimentary rocks is responsible for the falls at this point. The occurrence is briefly described by Pye (1962, p.20).

CLAY RESOURCES

The widespread occurrence of clay in Ontario is principally related to the glacial history of the province. Most areas are covered by a mantle of stony clay (i.e. till) that was deposited on the land by the melting of the most recent glacial ice 5,000 to 14,000 years ago. At the same time, stoneless clays were being deposited in horizontal layers in successive high-level lakes in the Great Lakes basins, and from marine waters in the Ottawa-St. Lawrence Lowlands. Subsequent reworking and redistribution of these glacial and marine clays has created further deposits of stoneless clay, often with improved ceramic properties.

A thorough account of the glacial history of Canada, much of it dealing with Ontario, is given by Prest (1970, p.675-764). Glacial events in Ontario, and a discussion of the various clays, are also outlined by Guillet (1967, p.113-123).

It is the stoneless clays that are of prime interest for clay products, and the most common of these in Ontario is varved clay. Varved clays are characterized by thin rhythmic alternations of clay and silt that reflect winter and summer deposition from lake waters subject to annual freeze-over conditions. Figure 8 shows the maximum extent of the great glacial lakes, the forerunners of today's Great Lakes. Varved clays may be found in suitable depressions wherever the glacial lakes overlapped the present shoreline.

Although till is the most common clay throughout Southwestern Ontario, much of it is relatively stonefree in the top several feet, and this has been extensively used by a prolific drain tile industry for more than a century. Subsequent inundation of the till plain by a series of high-level lakes ancestral to Lake Erie has effected a sifting and sorting action that has resulted in the settling of stones to lower levels. Elsewhere the gradual accumulation of stratified stonefree clays has been accomplished in shallow depressions through the agency of surface run-off from highland areas of till.

In the lower Ottawa and St. Lawrence valleys marine clay is distinctive and widespread. The Champlain Sea, connected through the Hudson valley to the Atlantic, occupied this area in the wake of the receding ice, 10,000 years ago, leaving thick deposits of stratified clay and sand.

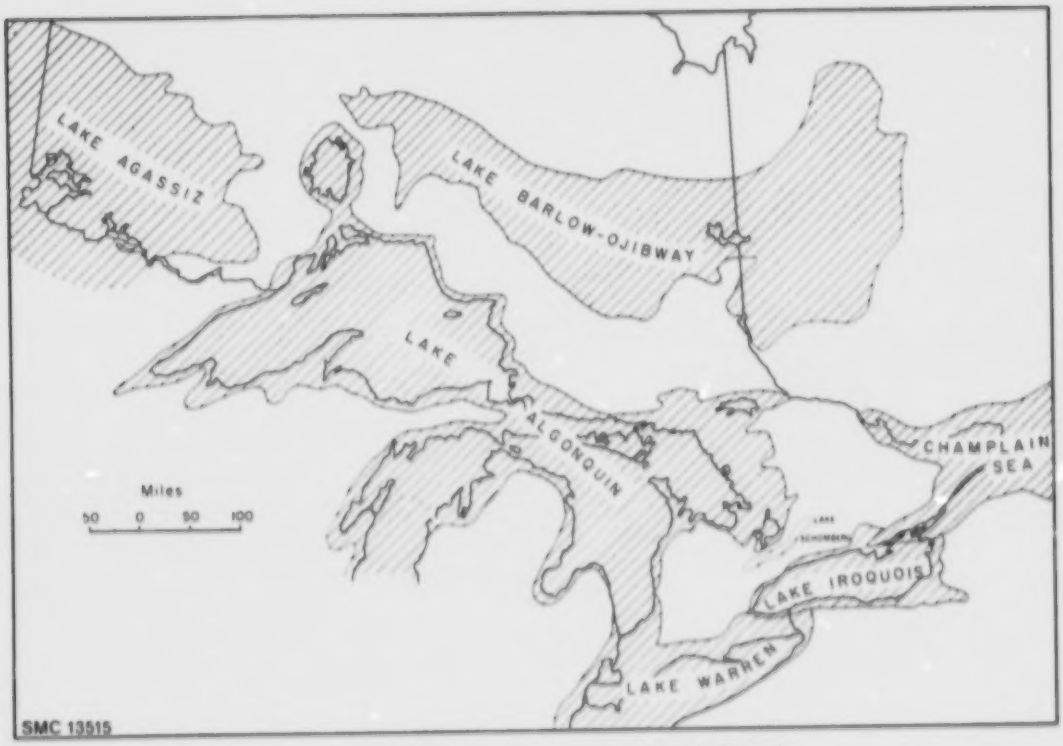


Figure 8 – Maximum extent of glacial lakes in Ontario.

Figure 9 – General ceramic properties of Ontario clays.

At about the same time a small deposit of red clay was accumulating in a lagoon of Lake Iroquois in the Hamilton-Aldershot area. Derived almost exclusively from eroding banks of Queenston Shale, the clay has ceramic properties superior to all others in Ontario except for the kaolinitic ones of the James Bay Lowland.

Although restricted to the Toronto area, and now unavailable due to urban development, the interglacial Scarborough and Don formations were the basis of an important chapter in Ontario's brick industry. Deposited in a warm climate prior to the last (Wisconsinan) ice age, these stratified clays and sands somehow survived the destructive forces of the subsequent glaciation.

The ceramic properties of Ontario clays have been generally summarized in a previous report (Guillet 1964) and are illustrated in Figure 9. The report by Keele (1924) detailing the chemical and ceramic properties of clays and shales throughout Ontario is as relevant today as it was half a century ago.

The following pages describe clays sampled during the years 1962-1965. Wherever possible the sampling was done by means of vertical channeling in exposed clay banks. Hence, descriptions of the clay layers are given in feet and inches, a measure of the thickness of the clay units in all cases.

A number has been assigned to each sample location to correspond with that on Map 2358 (back pocket).

Clays of Eastern Ontario

The most widespread clays of Eastern Ontario are the marine clays. These were deposited from the Champlain Sea that occupied the lower Ottawa and St. Lawrence valleys in the wake of the retreating glacial ice. The clay is particularly common between Hawkesbury and Ottawa, underlying broad flat plains marginal to the Ottawa River. A uniform but thin capping of sand on these clay plains reflects shallow water and beach conditions coincident with the final retreat of the marine waters. North of Ottawa to Pembroke, sand and silt increase at the expense of clay, marking the extremities of the sea in this direction. Prest (1970, p.713-729) gives an excellent account of these events.

Terasmae (1965) details the surficial geology in the Cornwall area. In addition to the marine clays he recognizes underlying varved clay remnants that indicate an early glacial lake prior to the Champlain Sea. However, exposures of the varved clays are scarce and of little significance.

Keele (1924, p.50-70) gives a good account of the clays and their chemical and ceramic properties. Wilson (1963) states that clays tested from Kingston, Cornwall, and Prescott show promise for use in the manufacture of coated lightweight aggregates.

Clay samples from a number of locations in Eastern Ontario are described on the following pages. Chemical, mineralogical and ceramic data are given in Tables 14, 15 and 16.

KINGSTON (1)

Clay is exposed in the shallow bank of Little Cataraqui Creek in Kingston Township. It was sampled in concession IV 1 km (1 mile) west of county road 10, 0.8 km (½ mile) north of Highway 401. The clay is limited to the narrow creek valley but may occur also in other parallel valleys nearby.

Sample 63-631: A 1 m (3 feet) section of mottled olive-grey and brown, massive, stoneless but gritty, moderately plastic clay is topped by 15 cm (6 inches) of clay loam and sod.

GANANOQUE (2)

Clay is fairly widespread in an undulating plain west of Gananoque. A 1.5 m (5 feet) roadside bank was sampled 5 km (3 miles) west of Gananoque and 0.4 km (¼ mile) north of Highway 2. A further depth of perhaps 5 m (15 feet) of clay may occur below the level sampled.

Sample 63-632: The exposed 1.5 m (5 feet) section consists of massive, blocky, dark brown clay with numerous lime concretions and rare pebbles and boulders.

SAMPLE DESCRIPTIONS FOR TABLES 14, 15 AND 16

63-631: Kingston (1); bank of Little Cataraqui Creek, ⅛ mile (0.8 km) north of Highway 401; 3 feet (1 m) of gritty grey-brown clay.

63-632: Gananoque (2); roadbank 3 miles (5 km) west of Gananoque and ¼ mile (0.4 km) north of Highway 2; 5 feet (1.5 m) of brown clay.

63-633: Waterton (3); creek bank 1 mile (1.6 km) east of Waterton and ⅛ mile (0.8 km) south of Highway 2; 4 feet (1 m) of green-grey silty clay.

63-634: Cornwall (4); creek bank at northeast corner of Tollgate Road and Pitt St. N.; 5 feet (1.5 m) of smooth grey clay.

63-635: Harrisons Corners (5); Raisin River bank 2 miles (3 km) east of Harrisons Corners; 6 feet (2 m) of smooth grey clay.

63-636: Alexandria (6); excavation for sewage treatment plant north of CNR 1 mile (1.6 km) east of Alexandria; 4 feet (1 m) of stiff brown clay.

63-637: Hawkesbury (7); house excavation 1 mile (1.6 km) west of town on old Highway 17; 5 feet (1.5 km) of smooth red-brown clay.

63-638: L'Original (8); Ottawa River bank 1⅛ miles (2.4 km) we of L'Original; lower 10 feet (3 m) of smooth red-brown clay.

63-639: L'Original (8); Location as above; next 6 feet (2 m) of smooth grey clay.

63-640: L'Original (8); Location as above; next 10 feet (3 m) of olive-grey clay.

63-641: L'Original (8); Location as above; upper 4 feet (1 m) of rubbly clay.

63-641A: L'Original (8); Location as above; 30 feet (9 m) bank composite of above four samples.

63-642: Renfrew (9); creek bank 1 mile (1.6 km) northeast of Admaston, 6 miles (10 km) west of Renfrew; 4 feet (1 m) of sandy brown clay.

63-643: Renfrew (9); roadcut, location as above; 8 feet (2 m) of massive brown clay.

63-644: Forrester's Falls (10); creek bank at bridge 1 mile (1.6 km) east of town; lower 10 feet (3 m) of silty grey clay.

63-645: Forrester's Falls (10); location as above, upper 17 feet (5 m) of stratified silt, sand, and clay.

TABLE 14 CHEMICAL ANALYSES – EASTERN ONTARIO CLAYS.

Sample No.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	TiO_2 %	CO_2 %	H_2O^+ %	H_2O^- %	SO_3 %	MnO %	Total %	Loss on Ignition %	Soluble Salts %
63-631	—	—	7.60	2.41	—	—	—	—	—	—	—	—	—	—	7.33	1.14
63-632	—	—	6.78	5.08	—	—	—	—	—	—	—	—	—	—	9.16	1.08
63-633	—	—	6.20	2.32	—	—	—	—	—	—	—	—	—	—	7.22	0.74
63-634	—	—	6.75	2.28	—	—	—	—	—	—	—	—	—	—	6.71	0.55
63-635	—	—	6.72	4.71	—	—	—	—	—	—	—	—	—	—	7.06	0.63
63-636	—	—	7.48	2.69	—	—	—	—	—	—	—	—	—	—	7.99	0.78
63-637	—	—	8.18	2.50	—	—	—	—	—	—	—	—	—	—	6.68	2.31
63-638	—	—	8.00	4.18	—	—	—	—	—	—	—	—	—	—	6.73	1.57
63-639	—	—	7.74	4.17	—	—	—	—	—	—	—	—	—	—	7.31	1.87
63-646	—	—	7.59	4.68	—	—	—	—	—	—	—	—	—	—	8.10	1.39
63-641	—	—	8.40	2.66	—	—	—	—	—	—	—	—	—	—	7.03	1.29
63-641A	53.3	16.4	7.94	3.80	4.62	2.60	3.12	0.68	1.96	2.76	1.77	0.32	0.13	99.4	7.12	—
63-642	—	—	7.16	2.52	—	—	—	—	—	—	—	—	—	—	5.89	2.14
63-643	—	—	8.20	3.03	—	—	—	—	—	—	—	—	—	—	4.96	2.59
63-644	—	—	5.47	8.85	—	—	—	—	—	—	—	—	—	—	7.69	0.84
63-645	—	—	5.27	3.80	—	—	—	—	—	—	—	—	—	—	4.67	1.00

TABLE 15 MINERAL ANALYSES – EASTERN ONTARIO CLAYS.

Sample No.	Non-clay minerals: Quartz	Calcite	Dolomite	Soda-lime feldspar	Potash feldspar	Amphibole	Clay minerals: Illite	Chlorite	Expanding mineral
	%	%	%	%	%	%			
63-631	16	<0.5	1	2	1	1-5	A	C	–
63-632	18	2	6	5	1	1-5	A	C	C
63-633	23	1	2	7	1	1	C	–	A (M)
63-634	26	0.5	0.5	5	1	1-5	A	C	C
63-635	22	3	2	7	1	1-5	A	B	C (I)
63-636	22	0.5	1	4	1	1-5	A	C	C (I)
63-637	16	0.5	2	6	<0.5	1-5	A	B	C (I)
63-638	12	2	1	7	1	1-5	A	B	D
63-639	14	2	2	6	<0.5	1-5	A	A	–
63-640	22	2	2	6	1	1-5	A	A	D
63-641	14	<0.5	1	7	1	1-5	A	C	C (I)
63-642	16	<0.5	1	6	1	1-5	A	–	C (I)
63-643	15	<0.5	1	7	1	1-5	A	D	–
63-644	13	6	6	9	<0.5	1-5	A	B	C (I)
63-645	29	<0.5	7	7	1	1-5	A	C	C (I)

(M = Montmorillonite; I = Interlayered)
(A = Abundant; B = Moderate; C = Minor; D = Trace)

TABLE 16 CERAMIC PROPERTIES — EASTERN ONTARIO CLAYS.

Sample	% Water of plasticity	% Drying Shrinkage	PCE	Fired Characteristics							
				Cone*	% Firing Shrinkage	% water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
63-631	33	7.7	3-4	010	2.7	15.6	16.3	1.86	Salmon	Almost hard	Smooth textured and attractive.
				06	6.9	8.7	9.3	2.10	Salmon-red	Hard	
				03	9.5	0	0.5	2.32	Red-brown	Very hard	
63-632	31	6.0	1-2	010	1.2	19.3	20.1	1.76	Tan	Almost hard	Yellow speckled at higher cones.
				06	2.1	17.0	17.6	1.79	Salmon	Very hard	
				03	11.0	1.6	2.2	2.37	Dark red	Very hard	
63-633	25	8.2	4-5	010	0.5	12.0	13.4	1.96	Salmon	Almost hard	Attractive briquettes.
				06	2.0	9.6	11.5	2.03	Red	Hard	
				03	6.6	2.4	4.2	2.33	Dark red	Very hard	
64-634	30	8.0	4	010	1.1	13.2	14.9	1.93	Salmon	Almost hard	Fair.
				06	3.2	9.5	11.3	2.06	Salmon-red	Hard	
				03	8.0	1.3	2.4	2.35	Dark red	Very hard	
63-635	31	7.7	1-2	010	0.5	16.7	17.3	1.81	Tan	Almost hard	Smooth textured and attractive.
				06	0.9	15.3	15.8	1.85	Salmon-pink	Hard	
				03	10.0	0.9	1.3	2.41	Dark red	Very hard	
63-636	36	8.7	3-4	010	2.0	16.1	17.4	1.86	Salmon	Hard	Smooth textured and attractive.
				06	3.8	12.5	13.7	1.98	Dark salmon	Very hard	
				03	11.1	0.3	0.7	2.48	Dark red	Very hard	
63-637	35	8.2	2	010	1.8	16.9	17.5	1.82	Salmon	Hard	Smooth textured and attractive.
				06	5.4	10.2	10.7	2.04	Dark salmon	Very hard	
				03	11.2	0.1	0.3	2.43	Dark red	Very hard	
63-638	35	7.5	1-2	010	0.7	20.6	20.9	1.71	Tan	Almost hard	Heavy scum.
				06	2.2	17.1	17.5	1.81	Pink	Very hard	
				03	12.7	0.1	0.1	2.58	Dark red	Very hard	
63-639	34	7.5	2	010	0.9	19.5	19.8	1.75	Tan	Almost hard	Good except for scum.
				06	3.4	16.4	16.9	1.84	Pink	Very hard	
				03	11.9	0.1	0.3	2.58	Dark red	Very hard	
63-640	35	7.4	3-4	010	1.1	20.3	20.6	1.72	Tan	Almost hard	Slight scum.
				06	2.0	18.6	19.1	1.77	Pink	Very hard	
				03	12.7	0.1	0.3	2.57	Dark red	Very hard	
63-641	34	8.2	1-2	010	1.8	15.8	16.3	1.87	Pale salmon	Almost hard	Smooth textured and attractive.
				06	5.1	11.0	11.5	2.04	Salmon	Very hard	
				03	10.6	0.2	0.4	2.49	Red-brown	Very hard	
63-642	25	5.6	3-4	010	0.5	15.2	16.8	1.85	Pale salmon	Moderate	Fair.
				06	2.3	12.5	14.5	1.94	Pink	Almost hard	
				03	8.4	1.5	3.7	2.36	Red-brown	Very hard	
63-643	34	6.1	2	010	1.2	20.4	20.9	1.70	Tan	Almost hard	Fair, trace of scum.
				06	2.6	17.1	17.7	1.80	Salmon pink	Hard	
				03	12.6	0.2	0.4	2.53	Dark red	Very hard	
63-644	23	23	4.0	010	0	18.3	19.6	1.77	Cream grey	Moderate	Mottled and unattractive.
				06	0.2	17.2	20.1	1.77	Cream white	Moderate	
				03	1.4	14.0	18.5	1.83	Cream buff	Moderate	
63-645	23	4.8	4	010	0	15.2	16.8	1.84	Salmon	Moderate	Slight scum.
				06	0	14.6	16.5	1.85	Salmon	Almost hard	
				03	2.6	7.0	9.6	2.08	Dark red	Very hard	

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), cone 06 (1840°F), cone 03 (1980°F).

WATERTON (3)

Clay probably underlies a number of shallow valleys between rock ridges in Front of Escott Township in the County of Leeds. A shallow creek bank section was sampled about 2 km (1 mile) east of Waterton and 0.8 km (½ mile) south of Highway 2. Waterton is about 20 km (12 miles) east of Gananoque.

Sample 63-633: The 1.2 m (4 feet) clay section exposed in the creek bank is green-grey in colour, massive, silty and gritty but stoneless, grading upwards into mottled brown and grey rubbly clay loam. A slight whitish efflorescence is characteristic of the upper part of the soil profile.

CORNWALL (4)

Deposits of marine clay occupy shallow depressions between extensive areas of till in the lower St. Lawrence region of Ontario. In some cases soft marine clay is overlain by more recent deposits of stratified sand and silty clay. A bank of the South Raisin River near the intersection of Pitt Street North and the Toll Gate Road in the north end of Cornwall was sampled.

Sample 63-634: A 1.5 m (5 feet) section represents the entire river bank and consists of 1 m (3 feet) of greasy grey clay mottled with rusty brown at the base. The clay is massive, plastic, smooth but weak, and is sharply overlain by 0.3 m (1 foot) of sandy loam containing scattered limestone and rusty sandstone pebbles, grading into the top foot of grey-brown, rubbly, stoneless, clay loam and sod.

Surficial geology of the Cornwall area, including Map 1175A and descriptions of the clays in the area, is given by Terasmae (1965).

HARRISONS CORNERS (5)

Another river bank sample of marine clay was taken at a point 3 km (2 miles) east of Harrisons Corners, some 13 km (8 miles) northwest of Cornwall. A 2 m (6 feet) bank on the main branch of the Raisin River, which occupies a valley about 0.8 km (½ mile) wide at this point, gave access to the clay.

Sample 63-635: The sample is representative of the lower 1.2 m (4 feet) of the bank, consisting of massive, grey, greasy marine clay. The clay is stoneless but contains rare rusty streaks and a few fine roots.

ALEXANDRIA (6)

A shallow section of marine clay was sampled in excavations for settling ponds for a new sewage treatment facility 1.6 km (1 mile) east of Alexandria on the north side of the Canadian National Railway lines.

Sample 63-636: A 1.2 m (4 feet) sample of stiff, massive olive-brown clay, finely laminated at the base and loamy at the top, is without stones or roots.

HAWKESBURY (7)

Marine clay occurs extensively in the lower end of the Ottawa River valley. In most places it is overlain by a thin layer of sand that marks the last stages of the shrinking Champlain Sea. An excavation for a house foundation provided access to the clay about 1.6 km (1 mile) west of the centre of town on old Highway 17.

Sample 63-637: 1.5 m (5 feet) of greasy, massive, stoneless, red-brown clay, drying tan, and becoming rubbly beneath sod at the top.

L'ORIGNAL (8)

Marine clay is well-exposed in the banks of the Ottawa River west of Hawkesbury where a broad level plain capped by a veneer of sand extends for many miles. The 9 m (30 feet) river bank 3.4 km (1½ miles) west of L'Orignal is illustrated in Figure 10. Four samples were taken as follows.

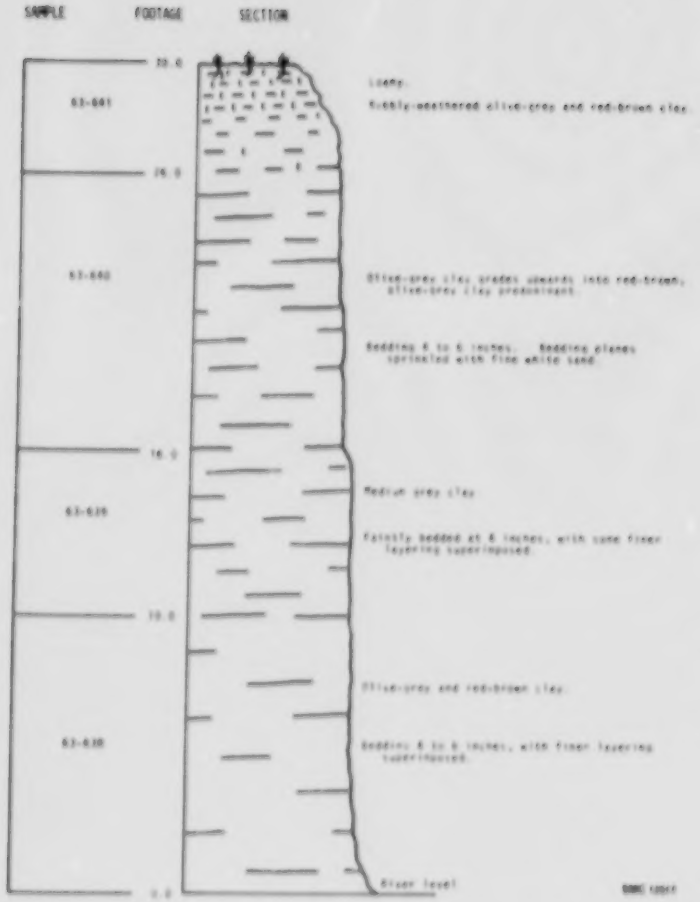
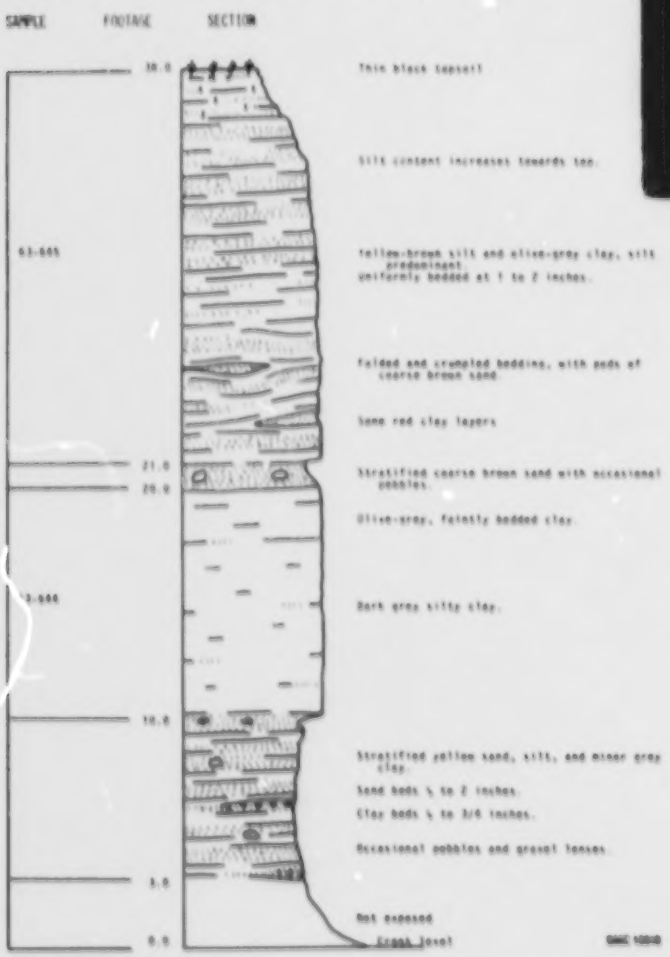


Figure 10 – Marine clay at L'Orignal.

Photo 4 – Stratified sand and clay at Forrester's Falls.

Figure 11 – Marine clay at Forrester's Falls.


SAMPLE
FOOTAGE
SECTION
Thin black topsoil
Silt content increases towards top.
Yellow-brown silt and olive-grey clay, silt predominant, uniformly bedded at 1 to 2 inches.
Folded and crumpled bedding, with pods of coarse brown sand.
Some red clay layers
Stratified coarse brown sand with occasional pebbles.
Olive-grey, faintly bedded clay.
Dark grey silty clay.
Stratified yellow sand, silt, and minor grey clay.
Sand beds ½ to 2 inches.
Clay beds ½ to 3/4 inches.
Occasional pebbles and gravel lenses.
Not exposed
Creek level

Sample 63-641: The upper 1 m (4 feet) of rubbly-weathered olive-grey and red-brown clay, becoming loamy at the top.

Sample 63-640: Three metres (10 feet) of coarsely stratified olive-grey and red-brown clay in beds 10-15 cm (4-6 inches) thick. Each bed is characterized by a predominance of olive-grey clay grading upwards into red-brown clay which terminates aburptly in a bedding plane that is usually sprinkled with fine white sand.

Sample 63-639: Two metres (6 feet) of medium grey, smooth, faintly bedded (10 cm; 4 inches thick) with a finer stratification superimposed.

Sample 63-638: The bottom 3 m (10 feet) of the bank consist of olive-grey and red-brown clay in beds 10-15 cm (4-6 inches) thick as before, with a finer stratification superimposed. The clay is smooth and without stones, shells, and roots.

Sample 63-641A: This is a composite sample made up from the previous four in amounts proportional to the vertical extent of each.

RENFREW (9)

Marine clay is exposed in a roadcut 1.6 km (1 mile) northeast of Admaston, some 10 km (6 miles) west of Renfrew. The exposure is in the broad level valley of the Bonnechere River. A second clay exposure is in a nearby creek bank. Stratigraphically it occupies a position about 3 m (10 feet) lower than the roadcut; it appears to consist of reworked marine clay. Two samples were taken as follows.

Sample 63-643: A 2 m (8 feet) sample from the roadcut consists of massive brown, blocky, marine clay, drying pale grey.

Sample 63-642: The upper 1 m (4 feet) of a 2 m (6 feet) creek bank is rather sandy but stoneless, rubbly, brown clay with a few fine roots.

FORRESTER'S FALLS (10)

The marine clay sequence becomes more noticeably stratified and sandy as one proceeds up the Ottawa Valley towards Pembroke. A 12 m (38 feet) creek bank section at the bridge 1.6 km (1 mile) east of Forrester's Falls is illustrated in Figure 11. Two samples were taken as follows.

Sample 63-645: The top 5 m (17 feet) of the bank consist of uniformly stratified yellow-brown silt and fine sand, and olive-grey clay and red clay, in layers 2.5-5 cm (1-2 inches) thick. The clay fraction decreases towards the top, consistent with the waning stages of the Champlain Sea. Folded and crumpled bedding, with pods of coarse brown sand, is common near the base. Stratification is lost in the top few feet, and the bank is topped by a thin layer of black soil and sod.

Sample 63-644: A 3 m (10 feet) section of dense, massive, uniform grey clay overlying stratified yellow sand and silt clay becomes faintly bedded and olive-grey in colour in the top 1 m (3 feet).

Clays of Central Ontario

The clays of the Central Ontario region offer the greatest variety to be found in Ontario. Their potential as a resource was discussed by Vos (1975). However, their utilization has generally been in decline since the 1920's and the pressures of urbanization have all but eliminated the best of them from future availability.

Pre-Wisconsinan interglacial clays unique to the Toronto area were known as the Scarborough and Don beds. Clay of the Scarborough beds was prized in earlier years for the rich maroon-coloured soft-mud bricks which it produced. It was formerly used by six plants on Greenwood Avenue (Keele 1924, p.106) in east central Toronto. The last one closed in 1962 (Guillet 1967, p.193-197).

The interglacial deposits of the Toronto region were deposited about 100,000 years ago, prior to the last (Wisconsinan) glacial stage. In distribution they appear to be restricted to an area within about 8 km (5 miles) of the Lake Ontario shore, extending between the Humber River on the west and Highland Creek on the east. A thick cover of overburden, consisting of Wisconsinan till and varved clay, and Lake Iroquois sand, has restricted exposures to deeply-cut river banks, Scarborough bluffs, and subway excavations.

CLAYS OF CENTRAL ONTARIO

SAMPLE DESCRIPTIONS FOR TABLES 17, 18 AND 19

62-501: Aldershot (11); creek bank west of King Road near Highway 403; 4½ feet (1.4 m) of smooth red clay.
62-502: Aldershot (11); face of shallow clay pit of National Sewer Pipe Ltd.; 2½ feet (0.7 m) of red clay.
62-503: Aldershot (11); culvert excavation for Highway 403; 5 feet (1.5 m) of red clay.
62-504: Aldershot (11); another culvert excavation in the Aldershot area; 6 feet (2 m) of red clay.
62-505: Aldershot (11); another culvert excavation in the Aldershot area; 2½ feet (0.7 m) of red clay.
62-506: Aldershot (11); another culvert excavation in the Aldershot area; 3 feet (1 m) of red clay.
62-506A: Aldershot (11); composite of previous six samples.
62-507: Aldershot (11); bank exposure during Highway 403 construction; 10 feet (3 m) of grey till.
62-508: Aldershot (11); culvert excavation for Highway 403; 2 feet (0.6 m) of red clay.
62-509: Aldershot (11); pit face of Natco Building Products Ltd.; 4½ feet (1.4 m) of red clay.
62-515: Scarborough Bluffs (12); 2,000 feet (600 m) west of the mouth of Highland Creek, top 4 feet (1.2 m) of the 45-foot (14 m) bank; loamy brown clay.
62-514: Scarborough Bluffs (12); location as above, next 10.5 feet (3.2 m) below the previous sample; stratified silt and sand.
62-513: Scarborough Bluffs (12); location as above, next 14 feet (4 m) below the previous sample; silty clay and sand.
62-512: Scarborough Bluffs (12); location as above, next 6 feet (2 m) below the previous sample; fine sand.
62-511: Scarborough Bluffs (12); location as above, bottom 10 feet (3 m) of the 45 foot (14 m) bank; tough silty clay.
62-515A: Scarborough Bluffs (12); location as above, composite of previous five samples.
62-510: Frenchman Bay (13); on the east bank of Rouge River at the railway bridge near its mouth; 12.5 feet (3.8 m) of tough brown clay.
65-658: Aurora (14); roadcut on the north bank of the Holland River, a mile (1.6 km) east of Aurora; top 10 feet (3 m) of the 24-foot (7 m) bank.
65-657: Aurora (14); location as above; next 9 feet (3 m) of grey silty clay.
65-656: Aurora (14); location as above; bottom 2 feet (0.6 m) of sticky clay.
65-659: Aurora (14); location as above; composite of previous three samples.
65-567: Beeton (15); river bank 1 mile (1.6 km) west of Beeton, Tecumseth Tp.; top 3 feet (1 m) of grey silty clay.
62-566: Beeton (15); location as above; lower 2½ feet (0.7 m) of silty clay.
62-568: Beeton (15); Angus (16); bank of Nottawasaga River, 3 miles (5 km) southeast of Angus on the Vth concession road; 8 feet (2 m) of varved clay.
62-572: Wyevale (17); eroded bank of Wye River, 1¼ miles (2 km) south of Wyevale; 12 feet (3 m) of coarsely varved clay.
62-573: Wyevale (17); roadside pit 1,000 feet (300 m) west of above location; 3 feet (1 m) of thinly varved clay.
62-571: Port McNicoll (18); drainage ditch along road between concession IV and V; 3 feet (1 m) of silty brown clay.
62-593: Coldwater (19); excavation 1,000 feet (300 m) north of the junction of Highways 400 and 12; top 3½ feet (1 m) of brown silty clay.
62-592: Coldwater (19); location as above; 5 feet (1.5 m) of brown clay underlying previous sample.
62-591: Coldwater (19); location as above; 5 feet (1.5 m) of grey varved clay in the bottom of the 13½ foot (4 m) excavation.
62-570: Uhthoff (20); west bank of North River 2 miles (3 km) north of Uhthoff; 3½ feet (1 m) of laminated brown clay and silt.
62-569: Uhthoff (20); location as above; 3 feet (1 m) of massive brown clay.
63-656: Lindsay (21); ¼ mile (0.4 km) east of the junction of Highways 35 and 7; 3 feet (1 m) of grey silty clay.
62-618: Bracebridge (22); west bank of the North Muskoka River 2 miles (3 km) north of Bracebridge; upper 7½ feet (2 m) of varved clay.
62-617: Bracebridge (22); location as above; 9 feet (3 m) of varved clay underlying previous sample.
62-616: Bracebridge (22); location as above; lower 7 feet (2 m) of coarsely varved clay.
62-618A: Bracebridge (22); location as above; composite of preious three samples.
62-647: Dorset (23); location unknown; bulk sample of grey silty clay submitted by Mr. John Tow.
62-615: Huntsville (24); pit at Melissa, 6 miles (10 km) north of Huntsville, 8 feet (2 m) of grey varved silt.
63-630: Port Dover (25); Lake Erie shorecliff 1 mile (1.6 km) west of Port Dover; top 4 feet (1 m) of brown silty clay.
63-629: Port Dover (25); location as above; middle 25 feet (8 m) of massive brown silty clay.
63-628: Port Dover (25); location as above; lower 20 feet (7 m) of layered silt and clay.
763-630A: Port Dover (25); location as above; composite of previous three samples.
62-587: Port Rowan (26); abandoned tile yard on north side of Port Rowan; 4½ feet (1.4 m) of laminated brown clay.
62-586: Port Rowan (26); location as above, 9½ feet (3 m) of brown silty clay.

TABLE 17 CHEMICAL ANALYSES – CENTRAL ONTARIO CLAYS.

Sample No.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	TiO_2 %	CO_2 %	H_2O^+ %	H_2O^- %	SO_3 %	MnO %	Total %	Loss on Ignition %	Soluble Salts %
62-501	–	–	5.07	1.50	–	–	–	–	–	–	–	–	–	–	8.00	0.67
62-502	–	–	3.74	1.86	–	–	–	–	–	–	–	–	–	–	4.80	0.68
62-503	–	–	7.16	2.17	–	–	–	–	–	–	–	–	–	–	8.64	1.31
62-504	–	–	6.40	3.58	–	–	–	–	–	–	–	–	–	–	8.11	0.79
62-505	–	–	6.95	1.01	–	–	–	–	–	–	–	–	–	–	7.60	0.97
62-506	–	–	6.60	0.81	–	–	–	–	–	–	–	–	–	–	6.86	1.04
62-506A	59.8	14.7	6.71	2.10	2.60	0.62	3.96	0.70	2.02	3.90	1.58	0.32	0.15	99.2	7.88	–
62-507	–	–	3.70	18.62	–	–	–	–	–	–	–	–	–	–	19.45	0.76
62-508	–	–	1.90	1.00	–	–	–	–	–	–	–	–	–	–	6.06	1.14
62-509	–	–	4.78	4.87	–	–	–	–	–	–	–	–	–	–	7.59	0.93
62-515	–	–	4.40	3.09	–	–	–	–	–	–	–	–	–	–	5.51	0.78
62-514	–	–	3.16	5.63	–	–	–	–	–	–	–	–	–	–	5.66	0.99
62-513	–	–	3.60	6.42	–	–	–	–	–	–	–	–	–	–	8.84	0.67
62-512	–	–	3.55	6.24	–	–	–	–	–	–	–	–	–	–	6.91	0.85
62-511	–	–	3.88	6.07	–	–	–	–	–	–	–	–	–	–	8.45	0.93
62-515A	60.7	12.3	4.00	5.95	2.14	2.08	2.55	0.56	4.24	3.42	1.44	0.27	0.08	99.7	6.87	–
62-510	–	–	3.08	17.90	–	–	–	–	–	–	–	–	–	–	17.19	1.11
65-658	–	–	3.06	20.50	–	–	–	–	–	–	–	–	–	–	16.79	0.84
65-657	–	–	2.92	27.70	–	–	–	–	–	–	–	–	–	–	23.19	1.01
65-656	–	–	3.03	26.20	–	–	–	–	–	–	–	–	–	–	22.25	0.88
65-659	39.14	8.20	3.78	18.67	5.05	1.52	1.89	0.40	17.98	1.17	0.78	Trace	–	98.6	19.97	–
62-567	–	–	6.47	3.31	–	–	–	–	–	–	–	–	–	–	9.47	0.88
62-566	–	–	4.31	11.40	–	–	–	–	–	–	–	–	–	–	10.67	0.92
62-568	–	–	4.30	16.50	–	–	–	–	–	–	–	–	–	–	17.35	0.86
62-572	–	–	4.33	13.30	–	–	–	–	–	–	–	–	–	–	13.21	0.72
62-573	–	–	6.62	4.86	–	–	–	–	–	–	–	–	–	–	8.52	0.98
62-571	–	–	6.41	2.92	–	–	–	–	–	–	–	–	–	–	5.32	0.78
62-593	–	–	5.95	3.80	–	–	–	–	–	–	–	–	–	–	6.53	0.59
62-592	–	–	5.37	6.09	–	–	–	–	–	–	–	–	–	–	8.67	0.62
62-591	–	–	6.02	7.12	–	–	–	–	–	–	–	–	–	–	9.56	0.80
62-570	–	–	7.21	2.58	–	–	–	–	–	–	–	–	–	–	7.68	0.98
62-569	–	–	4.37	18.20	–	–	–	–	–	–	–	–	–	–	17.16	1.14
63-646	–	–	3.18	13.30	–	–	–	–	–	–	–	–	–	–	13.06	1.57
62-618	–	–	7.62	2.42	–	–	–	–	–	–	–	–	–	–	5.70	0.84
62-617	–	–	7.03	2.92	–	–	–	–	–	–	–	–	–	–	3.74	0.92
62-616	–	–	5.17	3.37	–	–	–	–	–	–	–	–	–	–	1.20	0.34
62-618A	60.5	15.5	6.70	2.99	2.43	2.91	3.58	0.70	1.22	2.11	1.32	Nil	0.11	100.1	3.71	–
63-647	–	–	5.22	3.41	–	–	–	–	–	–	–	–	–	–	2.06	0.63
62-615	–	–	5.62	3.22	–	–	–	–	–	–	–	–	–	–	1.89	0.84
63-630	–	–	3.91	16.80	–	–	–	–	–	–	–	–	–	–	17.93	0.72
63-629	–	–	4.34	17.90	–	–	–	–	–	–	–	–	–	–	18.21	0.65
63-628	–	–	3.51	15.80	–	–	–	–	–	–	–	–	–	–	15.77	1.34
63-630A	45.8	9.39	3.99	17.70	3.42	1.15	2.31	0.59	14.39	1.79	0.80	0.49	0.10	101.9	17.23	–
62-587	–	–	3.53	13.50	–	–	–	–	–	–	–	–	–	–	15.43	0.57
62-586	–	–	3.78	14.20	–	–	–	–	–	–	–	–	–	–	15.56	0.86

TABLE 18 MINERAL ANALYSES – CENTRAL ONTARIO CLAYS.

Sample No.	Non-clay minerals: Quartz	Calcite	Dolomite	Soda-lime feldspar	Potash feldspar	Amphibole	Clay minerals: Illite	Chlorite	Expanding mineral
	%	%	%	%	%	%			
62-501	38	2	1	1	<1	–	A	C	ND
62-502	41	<1	<1	6	3	–	A	C	ND
62-503	22	3	1	<1	<1	–	A	C	ND
62-504	28	4	2	<1	1	–	A	B	ND
62-505	26	ND	ND	2	<1	–	A	B	ND
62-506	32	ND	ND	3	1	–	A	B	ND
62-507	19	31	4	3	1	<1	B	B	ND
62-508	39	ND	ND	3	1	–	A	C	D
62-509	33	7	1	5	1	–	A	C	C
62-515	26	1	ND	9	3	<1	A	C	C (I)
62-514	29	3	3	13	2	<1	A	B	C (I)
62-513	24	6	6	9	2	<1	A	B	C (IM)
62-512	23	9	7	15	5	<1	B	B	C (I)
62-511	27	5	5	7	3	<1	A	B	C (I)
62-510	21	41	3	6	2	<1	B	D	ND
65-658	30	32	5	5	3	<1	B	C	C
65-657	23	44	5	4	1	<1	B	D	C
65-656	24	44	9	6	1	ND	C	C	D
62-567	32	<1	<1	7	1	<1	C	C	A (M)
62-566	32	10	3	7	1	<1	C	C	A (M)
62-568	19	22	4	5	1	<1	A	C	C
62-572	22	15	7	<1	1	1-5	A	D	C (M)
62-573	22	4	<1	4	1	1-5	A	D	A (M)
62-571	30	ND	<1	7	1	1-5	A	ND	C
62-593	25	<1	3	6	1	1-5	A	B	C
62-592	25	1	6	6	1	1	A	B	B
62-591	18	8	2	5	1	1-5	A	B	B
62-570	18	ND	<1	6	1	1-5	A	D	B (I)
62-569	20	22	5	3	1	<1	A	D	C
63-646	22	34	4	3	3	1-5	C	C	C
62-618	20	ND	<1	5	1	1-5	A	D	C
62-617	23	ND	<1	9	1	1-5	A	D	C (I)
62-616	32	<1	15	10	2	1-5	A	D	ND
63-647	25	<0.5	2	8	1	1-5	A	–	C (I)
62-615	28	ND	2	5	1	1-5	A	D	B (I)
63-629	24	26	5	2	1	<1	B	B	–
63-628	40	21	1	4	1	1-5	B	B	–
62-587	29	14	8	4	1	<1	B	C	B
62-586	21	16	8	3	<1	ND	A	C	C

(M = Montmorillonite; I = Interlayered)
(A = Abundant; B = Moderate; C = Minor; D = Trace; ND = Not detected).

TABLE 19 CERAMIC PROPERTIES – CENTRAL ONTARIO CLAYS.

Sample	% water of Plasticity	% Drying Shrinkage	PCE	Cone*	Fired Characteristics: % Firing Shrinkage**	% water Absorption: 24-hr. cold	% water Absorption: 5-hr boiling	Specific Gravity	Colour	Hardness	Remarks
62-501	26	5.7	6	010	1.3	13.6	16.1	1.80	Salmon	Almost hard	Good quality.
				06	2.9	10.0	13.2	1.90	Dark salmon	Hard	
				03	3.9	1.9	3.9	2.25	Salmon Red	Very hard	
62-502	19	4.2	8	010	+0.4	12.6	17.6	1.84	Salmon	Almost hard	Sandy textured, attractive.
				06	+0.2	12.2	17.2	1.84	Dark salmon	Hard	
				03	1.2	9.6	15.2	1.90	Red	Very hard	
62-503	28	6.3	7	010	3.0	8.8	9.4	2.02	Salmon	Hard	Good except for slight scum.
				06	7.0	1.7	2.1	2.26	Salmon red	Very hard	
				03	+1.5	0.3	3.5	1.65	Red	Very hard	
62-504	22	4.4	4	010	1.2	11.8	12.5	1.93	Salmon	Hard	Good except for slight scum.
				06	3.5	6.8	8.1	2.07	Red	Very hard	
				03	6.3	0.9	1.1	2.28	Dark red	Very hard	
62-505	26	5.8	8	010	2.6	10.3	11.6	1.97	Salmon	Hard	Good quality.
				06	5.8	5.2	6.0	2.18	Red	Very hard	
				03	7.1	0.1	0.3	2.26	Dark red	Very hard	
62-506	24	5.2	8	010	2.6	9.3	10.0	2.03	Salmon	Hard	Good quality.
				06	5.7	4.2	4.6	2.25	Salmon red	Very hard	
				03	5.8	0.2	0.4	2.17	Dark red-brown	Very hard	
62-507	19	4.2	4	010	+1.2	22.9	24.1	1.56	Tan-cream	Medium	Attractive except for lime pops.
				06	+1.6	23.7	24.1	1.57	Cream	Medium	
				03	+1.2	23.4	27.6	1.59	Buff	Almost hard	
62-508	23	5.3	7	010	1.7	10.3	12.0	1.99	Salmon	Hard	Good quality.
				06	4.6	5.3	8.0	2.18	Dark salmon	Very hard	
				03	6.1	0.3	0.5	2.22	Dark brown	Very hard	
62-509	18	2.9	5-6	010	+0.2	12.4	15.2	1.91	Salmon	Hard	Fair, slight scum.
				06	0.0	12.0	15.1	1.91	Salmon-red	Hard	
				03	4.1	6.2	9.8	2.08	Dark red-brown	Very hard	
62-515	23	4.9	7	010	+0.7	15.4	18.7	1.79	Salmon	Almost hard	Good quality.
				06	+0.5	15.3	18.8	1.78	Dark salmon	Almost hard	
				03	1.9	10.1	14.8	1.91	Red	Very hard	
62-514	16	1.4	5-6	010	+1.4	18.1	23.8	1.66	Salmon	Soft	Sandy textured, rather weak.
				06	+1.0	14.6	21.2	1.73	Salmon	Medium	
				03	+0.8	12.8	20.2	1.74	Salmon brown	Almost hard	
62-513	22	4.7	4	010	+0.4	17.1	19.8	1.74	Tan	Almost hard	Slight scum.
				06	+0.7	16.3	19.5	1.75	Tan	Almost hard	
				03	0.51	13.7	17.9	1.80	Pink brown	Hard	
62-512	20	3.9	5-6	010	+0.7	18.3	25.3	1.64	Salmon	Soft	Sandy textured, attractive.
				06	+0.5	16.4	23.8	1.66	Salmon	Soft	
				03	+0.2	14.4	21.8	1.70	Salmon brown	Almost hard	
62-511	20	4.3	4	010	+0.4	16.5	19.0	1.76	Tan	Medium	Good except for slight scum.
				06	+0.5	15.7	19.2	1.76	Tan	Medium	
				03	0.6	12.6	17.1	1.84	Pink-brown	Almost hard	
62-510	20	4.9	2-3	010	+0.7	21.5	26.8	1.60	Cream-tan	Almost hard	Good quality.
				06	+1.6	21.4	27.0	1.57	Cream	Almost hard	
				03	+1.7	20.1	25.2	1.56	Buff	Almost hard	

Table 19 continued: CERAMIC PROPERTIES — CENTRAL ONTARIO CLAYS.

					Fired Characteristics							
	% water of Plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	% water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
65-658	20	3.9	4-5	010	0	25.4	26.7	1.59	Light tan	Nearly hard	Fairly attractive.
				06	+0.8	23.6	27.5	1.56	Cream tan	Nearly hard	
				03	+1.7	20.7	27.8	1.56	Cream buff	Nearly hard	
65-657	20	4.1	—	010	+1.8	34.4	34.4	1.43	Cream buff	Soft	Slightly cracked.
				06	+2.9	32.4	36.3	1.37	Grey buff	Soft	
				03	+3.3	31.6	37.0	1.35	Off white	Soft	
63-656	21	3.0	3-5	010	+4.3	36.3	42.1	1.32	Cream buff	Soft	Slightly cracked.
				06	+4.9	37.3	41.8	1.38	Grey buff	Soft	
				03	+6.3	37.7	44.2	1.35	Off white	Soft	
62-567	28	7.6	5	010	0.2	17.3	19.8	1.76	Dark salmon	Rather soft	Frequent lime pops.
				06	0.0	17.0	19.5	1.78	Salmon red	Mod. hard	
				03	5.4	6.4	9.7	1.73	Dark red	Very hard	
63-566	19	3.5	2	010	+1.4	21.4	24.7	1.66	Salmon	Rather soft	Fair quality.
				06	+1.0	18.5	23.6	1.67	Pink tan	Rather soft	
				03	0.8	16.7	23.5	1.68	Yellow-buff	Almost hard	
62-568	21	5.2	3	010	0.4	20.1	21.0	1.65	Cream tan	Rather soft	Smooth textured and attractive.
				06	0.0	20.1	22.1	1.64	Cream	Rather soft	
				03	0.9	18.0	23.1	1.69	Buff	Mod. soft	
62-572	23	4.2	2	010	+0.7	24.5	28.0	1.57	Grey-tan	Rather soft	Occasional lime pops.
				06	+0.9	24.4	28.4	1.57	Grey buff	Rather soft	
				03	0.4	15.9	22.3	1.74	Yellow buff	Hard	
62-573	22	7.2	2	010	0.7	17.6	18.9	1.69	Salmon	Almost hard	Greatly overfired at cone 03.
				06	3.3	13.0	14.6	1.91	Salmon red	Very hard	
				03	—	—	—	—	Dark red	Very hard	
63-571	28	5.8	3	010	0.4	17.4	19.1	1.76	Salmon-brown	Almost hard	Fair quality.
				06	1.2	15.3	17.6	1.81	Salmon	Almost hard	
				03	9.5	0.8	1.6	2.38	Dark red	Very hard	
63-593	26	6.4	3	010	0.7	13.7	14.6	1.88	Salmon	Hard	Good except for slight scum.
				06	2.3	10.9	12.6	1.95	Salmon pink	Almost hard	
				03	7.1	0.2	0.5	2.35	Dark red	Very hard	
63-592	23	5.5	3	010	0.0	14.9	16.0	1.84	Light salmon	Almost hard	Rare lime pops.
				06	0.5	13.7	14.6	1.85	Pink salmon	Almost hard	
				03	5.3	2.3	2.4	2.25	Red brown	Very hard	
63-591	20	6.9	3	010	0.7	19.2	19.9	1.72	Pink-tan	Almost hard	Streaked with yellow scum.
				06	1.2	18.3	18.9	1.73	Pink	Hard	
				03	8.6	0.8	1.1	2.37	Dark red	Very hard	
63-570	31	7.9	3	010	1.4	14.8	15.7	1.89	Salmon	Almost hard	Good quality.
				06	2.5	8.9	10.3	2.06	Salmon pink	Hard	
				03	7.9	0.2	0.5	2.35	Dark red	Very hard	
63-569	27	7.4	4	010	0.4	13.2	13.8	1.94	Salmon	Almost hard	Good quality.
				06	1.6	9.9	12.0	2.01	Salmon-red	Almost hard	
				03	6.9	0.6	0.8	2.43	Dark-red	Very hard	
63-646	17	3.3	4	010	+0.3	—	—	—	Pink-cream	Moderate	Mottled, unattractive.
				06	+1.0	17.4	22.4	1.69	Pink-cream	Moderate	
				03	—	—	—	—	Grey-cream	Moderate	

Table 15 continued: CERAMIC PROPERTIES – CENTRAL ONTARIO CLAYS.

				Fired Characteristics								
	% water of Plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	% water Absorption 24-hr. cold	% water Absorption 5-hr boiling	Specific Gravity	Colour	Hardness	Remarks
62-618	34	6.5	3	010	1.2	18.1	19.3	1.80	Tan-salmon	Almost hard	Good quality, smooth.
				06	6.2	9.6	10.5	2.08	Salmon pink	Very hard	
				03	10.2	0.2	0.4	2.42	Red-brown	Very hard	
62-617	28	4.7	2	010	0.4	18.3	20.3	1.76	Salmon tan	Mod. hard	Slightly mottled, scum, & fine cracks.
				06	1.0	15.8	18.6	1.81	Salmon	Almost hard	
				03	8.0	2.6	5.3	2.27	Dark red	Very hard	
62-616	21	2.6	5	010	+0.3	17.0	20.3	1.76	Light brown	Rather soft	Mottled, slight scum.
				06	13.4	16.2	20.0	1.76	Salmon pink	Rather soft	
				03	3.4	7.9	11.8	2.01	Dusky red	Hard	
62-647	21	0.7	5	010	+0.2	18.5	21.6	1.70	Tan	Very soft	Chalky but attractive.
				06	+0.2	18.4	22.0	1.68	Pink	Very soft	
				03	4.0	12.0	15.7	1.86	Pink-red	Moderate	
62-615	24	—	4	010	—	18.9	19.9	1.71	Tan	Soft	Chalky but smooth and uniform.
				06	—	18.0	19.1	1.74	Dark pink	Mod. hard	
				03	—	1.8	2.0	2.31	Dark red	Very hard	
63-629	22	4.8	3-4	010	0.5	18.6	19.3	1.69	Tan	Almost hard	Excellent appearance.
				06	0.5	18.9	20.6	1.69	Cream	Almost hard	
				03	0.4	19.5	23.4	1.68	Cream-buff	Almost hard	
63-626	18	3.3	4	010	+0.9	22.9	25.1	1.63	Pink-tan	Mod. hard	Chalky, attractive.
				06	+1.7	21.8	26.4	1.58	Tan-grey	Mod. hard	
				03	+1.7	21.4	27.4	1.58	Cream-buff	Almost hard	
62-587	18	4.5	4	010	0.0	20.0	22.2	1.71	Light salmon	Almost hard	Fair.
				06	+0.5	17.6	21.5	1.70	Tan	Almost hard	
				03	0.0	13.9	20.9	1.73	Buff	Hard	
62-586	20	5.0	3-4	010	0.5	17.1	18.1	1.79	Tan	Hard	Smooth and attractive.
				06	0.4	15.5	18.0	1.77	Light tan	Hard	
				03	1.4	12.0	17.6	1.83	Yellow-buff	Very hard	

*Equivalent temperatures measured by optical pyrometer: cone 010 (1660°F), cone 06 (1840°F), cone 03 (1960°F).
**A plus (+) sign indicates expansion.

The lowest unit known as the Don beds, is a fossil-bearing sequence of stratified sand, clay, and fine gravel, that was deposited in a lake 18 m (60 feet) higher than Lake Ontario at a time when the climate was about 3°C (5°F) warmer than the present (Terasmae 1960, p.39). The upper unit, known as the Scarborough beds, is a fossiliferous sequence of stratified clay, silt, and sand that was deposited in a lake 60 m (200 feet) higher than Lake Ontario when the climate was about 6°C (10°F) cooler than the present.

In the Hamilton area an unusually good quality clay was deposited in shallow lagoons separated from Lake Iroquois by bars of sand and gravel at the mouth of the Dundas valley. These clays were restricted in origin to the nearby eroding terraces of Queenston Shale, and were particularly valuable in the manufacture of sewer pipe, structural tile, and flower pots. The deposits were shallow and of limited extent, one extending into west Hamilton, the other east past Aldershot. The Hamilton deposit has long since been exhausted or rendered unavailable by urbanization. The Aldershot clay was effectively eliminated by the opening of Highway 403.

Elsewhere, glacial varved clays and more recent stratified clays reflect the predominantly limestone bedrock in their compositions, and are of limited value for heavy clay products.

The clays of Central Ontario show little value for production of lightweight aggregate (Wilson 1963).

Analytical data for the sampled sections described on the following pages are given in Tables 17, 18 and 19.

ALDERSHOT (11)

Second only to the Cretaceous clays of the James Bay Lowland, the Aldershot red clay is the best ceramic clay available in Ontario and the only domestic one that has been extensively used in the manufacture of flowerpots, structural tile, and sewer pipe. Derived from nearby eroding terraces of the Queenston Shale, the clay was restricted to a shallow occurrence in west Hamilton and one in the vicinity of Aldershot. The Hamilton deposit has been long since exhausted, and only remnants of the Aldershot clay were available for sampling in 1962. At that time National Sewer Pipe Limited was still recovering small amounts of the clay in an area just north of the Canadian National railway line and west of King Road (Guillet 1967, p.178-180). Keele (1924, p.95-97) also describes these clays.

Construction of Highway 403 was underway in 1962, and a number of excellent exposures of Aldershot clay was made available in culvert excavations. These revealed thicknesses of 1-2 m (2-6 feet) of dense plastic red clay in a strip 0.4 km (¼ mile) wide located on the north side of the Canadian National railway line between King Road and the plant of Natco Building Products Limited, a distance of about 5 km (3 miles). East of King Road the clays became browner in colour and more limy as a result of contamination with eroding till.

The red Aldershot clay owed its value to a very low lime content and to the natural beneficiation obtained by reworking and sizing of its constituent particles, which were derived from an already attractive ceramic source, the Queenston Shale. However, the construction of Highway 403 has effectively removed any further potential the area may have had as a source of quality clay.

Samples 62-501 to 62-506 inclusive represent thicknesses of red plastic Aldershot clay from 1-2 m (2¼ to 6 feet), taken primarily from culvert excavations over the length of the deposit but also from several natural bank exposures. Sample 62-506A is a composite of these samples.

Sample 62-507 represents a 3 m (10 feet) bank of grey till from south of the red clay area. It has a low to moderate content of stones, and is stratigraphically lower than the red clay and separated from it by lenses of sand and gravel.

Samples 62-508 and 62-509 represent 0.6 m and 1.3 m (2 and 4.3 feet) sections of red clay near the west end of its occurrence and in the vicinity of the quarry of Natco Building Products Limited.

SCARBOROUGH BLUFFS (12)

A part of the Scarborough Bluffs, about 600 m (2,000 feet) west of the mouth of Highland Creek, comprises an excellent section of interglacial clays, sands, and silts. The 14 m (45 feet) bank was divided into five sample intervals. These are described in the following notes and illustrated in Figure 12.

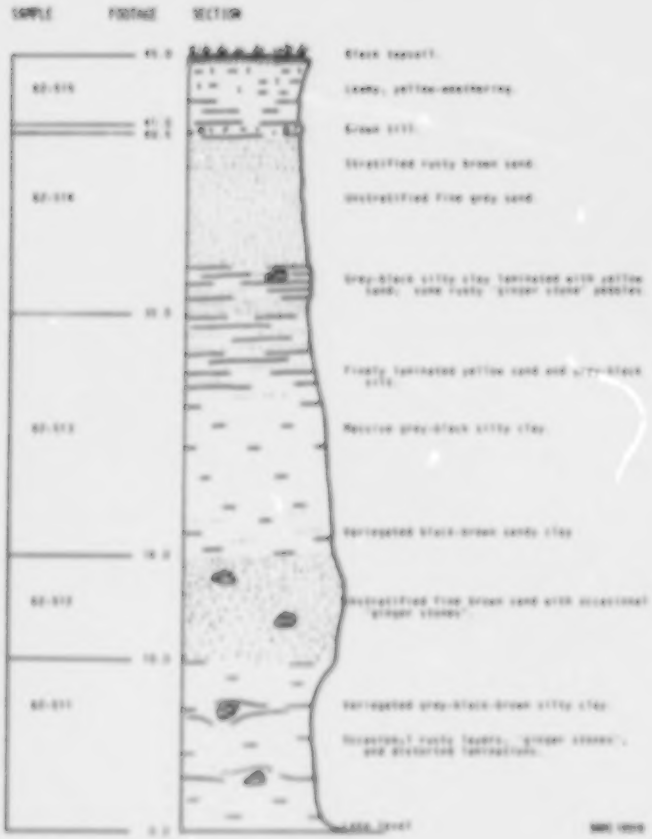


Figure 12 – Interglacial clay in the Scarborough Bluffs.

Sample 62-515: The top 1 m (4 feet) of the bank consist of medium brown loamy clay, drying yellow-buff.
Sample 62-514: A 3.2 m (10.5 feet) section of stratified fine sand and silty clay is separated from the above sampled section by 0.5 m (1.5 feet) of brown till.
Sample 62-513: A 4 m (14 feet) section of finely laminated sand, silt, and clay.
Sample 62-512: A 2 m (6 feet) section of dark brown unstratified fine sand.
Sample 62-511: The bottom 3 m (10 feet) of the bank consisting of tough grey-black brown silty clay.

In southern Ontario interglacial clays are apparently restricted to the immediate vicinity of Toronto. They were formerly extensively used in the manufacture of soft mud brick at six plants on Greenwood Avenue in east-central Toronto, where they were particularly prized for their rich maroon fired colour. These clays are further described by Guillet (1967, p.194-197). The Scarborough section is described by Karrow (1967, p.25-30).

FRENCHMAN BAY (13)

A sewer excavation in the east bank of the Rouge River at the railway bridge near Lake Ontario gave access to a section of stoneless clay overlying till. Sample 62-510 is representative of the 4 m (12.5 feet) clay section described below.

13 m (42.5 feet): Top of river bank.
12-13 m (40.0-42.5 ft.): Yellow-brown to grey-brown, drying buff-grey, loamy stoneless clay, grading into brown-black topsoil in upper foot. Fine roots common.
11-12 m (35.0-40.0 ft.): Medium brown, massive to poorly laminated, silty, stoneless clay. Distorted laminations near the bottom contain occasional whorls of fine sand. A few fine roots near the top.
9-11 m (30.0-35.0 ft.): Dark brown, smooth, tough, plastic clay laminated with medium brown silty clay with occasional yellow rusty streaks. Stoneless, uniform 1.2 cm (½ inch) laminations, and occasional black carbonaceous seams, some clove-brown plastic clay layers, and rare beds of fine yellow sand to 5 cm (2 inches) in thickness.
0-9 m (0.0-30.0 ft.): Till.
0 m (0.0 ft.): River level.

AURORA (14)

Stratified silt and clay, some of it varved, is exposed in the banks of the Holland River 1.6 km (1 mile) east of Aurora. It probably accumulated as deposition from the Schomberg pondings during the final retreat of the glacial ice, and was topped by subsequent flood plain deposition in the Holland River valley. The section is illustrated in Figure 13. Four samples were taken as follows.

Sample 65-658: The top 3 m (10 feet) of the 7 m (24 feet) section comprises finely stratified yellow and buff-grey silt grading upwards into laminated brown-grey clayey silt, loamy at the top. A few pebbles are present in the top layers.
Sample 65-657: The underlying 3 m (9 feet) consists of stratified buff-brown and yellow silt and silty clay grading upwards into varved clay.
Sample 65-656: Only 2 of the bottom 2 m (5 feet) of the bank was exposed, and this consisted of grey laminated silty clay.
Sample 65-659: A composite of the three previous samples.

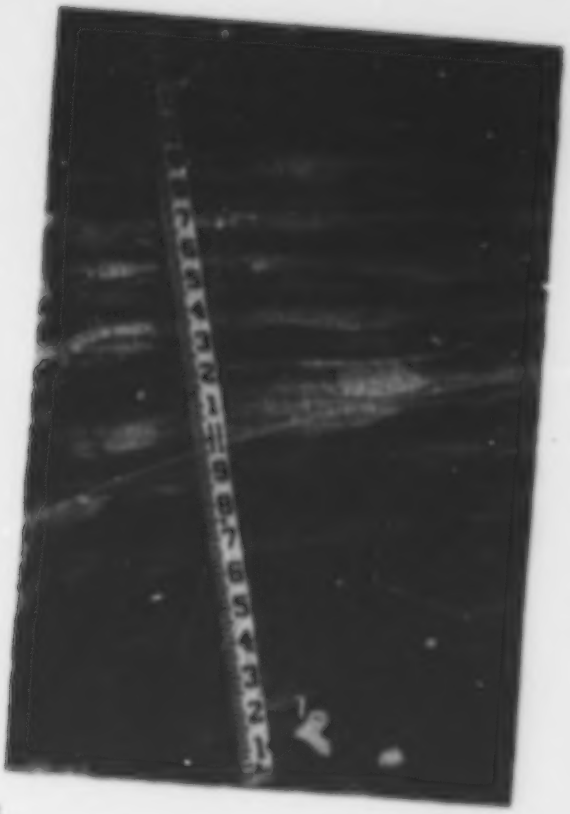
BEETON (15)

A shallow river bank 1.6 km (1 mile) west of Beeton in Tecumseth Township, Simcoe County, gave access to a thin sequence of flood plain clay and silt overlying till. Two samples were taken from the east bank 23 m (75 feet) north of the bridge.

Sample 62-567: The top 1 m (3 feet) consist of grey-brown rusty mottled, pale grey weathering, crumbly, stoneless silty clay with occasional small white shells and a few fine roots.
Sample 62-566: The bottom 1 m (2¼ feet) in predominantly a rusty-brown clayey silt and fine sand grading downwards into fine grey sand with a few stones.

Figure 13 -- Stratified clay at Aurora.

Photo 5 – Varved clay near Wyevale.



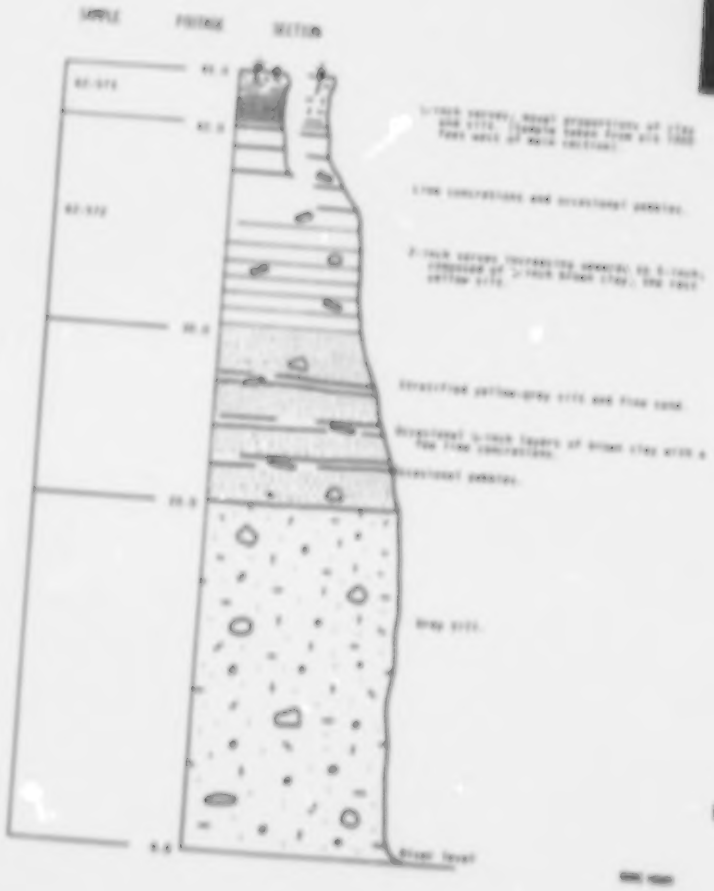


Figure 14 – Varved clay at Wyevale.

ANGUS (16)

Varved clay is exposed in a bank of the Nottawasaga River on the 5th concession road in Essa Township, 5 km (3 miles) southeast of Angus. Most of the 18 m (60 feet) bank appears to be varved clay, although only a 2 m (6 feet) section near the middle was well enough exposed for sampling, but up to 3 m (10 feet) of stratified sand occurs at the top. The sequence is consistent with the geological history of glacial Lake Algonquin, a high-level forerunner to Lake Huron.

A sample was taken near the middle of the bank on the north side of the river 90 m (100 yards) east of the bridge.

Sample 62-568: Two metres (6 feet) of finely varved (less than 0.6 cm; ¼ inch) smooth grey-brown clay and light coloured silt of low plasticity and strength.

WYEVALE (17)

Varved clay deposited from Lake Algonquin is exposed in the banks of the Wye River in Tiny Township. The sampled section was an eroded bank 180 m (200 yards) north of the road, about 2 km (1¼ miles) southeast of Wyevale, but similar sections can also be seen 1.6 km (1 mile) south of Wyebridge and along Highway 92 east of Wasaga.

Only a 4 m (12 feet) section near the top of the 14 m (45 feet) bank was sampled. Not sampled was an underlying 3 m (10 feet) section of stratified silt and sand with minor clay, and the lower 6 m (20 feet) of the bank which was till. The section is illustrated in Figure 14.

Sample 62-572: A 4 m (12 feet) section of coarsely varved clay, consisting of varve couplets 5 cm (2 inches) thick increasing upwards to 12 cm (5 inches), composed of 1.2 cm (½ inch) brown clay layers and yellow silt. White-weathering limy concretions are common in the clay layers with occasional pebbles. Clay layers are massive and uniform, but silt layers are faintly stratified in light and dark colouring. Thickness of the clay layers is constant, and the variation in overall size of each varve is due to varying thickness of the silt layer.

A second sample represents the top 1 m (3 feet) of a small roadside pit 300 m (1,000 feet) west of the previously described site. The 2 m (6 feet) pit face exposes a portion of the same coarsely varved unit previously sampled, but the top 1 m (3 feet) consist of thinly varved clay. The transition occurs over a vertical distance of about 0.3 m (12 inches).

Sample 62-573: One metre (3 feet) of thinly varved (1.2 cm; ½ inch) clay and silt in equal proportions, becoming loamy at the top.

PORT McNICOLL (18)

A thin veneer of clay was sampled on a broad plateau well above the level of Georgian Bay, in lot 11, concession IV, Tay Township. A drainage ditch along the road between concessions IV and V gave access to the clay.

Sample 62-571: A 1 m (3 feet) section consists of massive, tough, stoneless, silty brown clay mottled with olive-grey, topped by 20 cm (8 inches) of fine yellow sand and black loamy topsoil. The sampled unit overlies olive-grey silt.

COLDWATER (19)

Excavation for a motel cistern 300 m (1,000 feet) north of the junction of Highways 400 and 12 gave access to an interesting section of varved clay illustrated in Figure 15. Some of the lower varved units were complexly broken and disoriented as described below.

Sample 62-593: The top 1 m (3½ feet) is mainly massive grey-brown silty clay mottled with green-blue patches, but in places is finely laminated.

Sample 62-592: The middle 1.5 m (5 feet) consist of red-brown silty clay, slightly mottled with greenish and rusty patches, and mostly massive but with some fine stratification indicated by silt veneers at about 2.5 cm (1 inch) intervals.

Sample 62-591: The bottom 1.5 m (5 feet) is grey varved clay of which the middle portion is complexly broken into disoriented angular blocks. Varved clay both

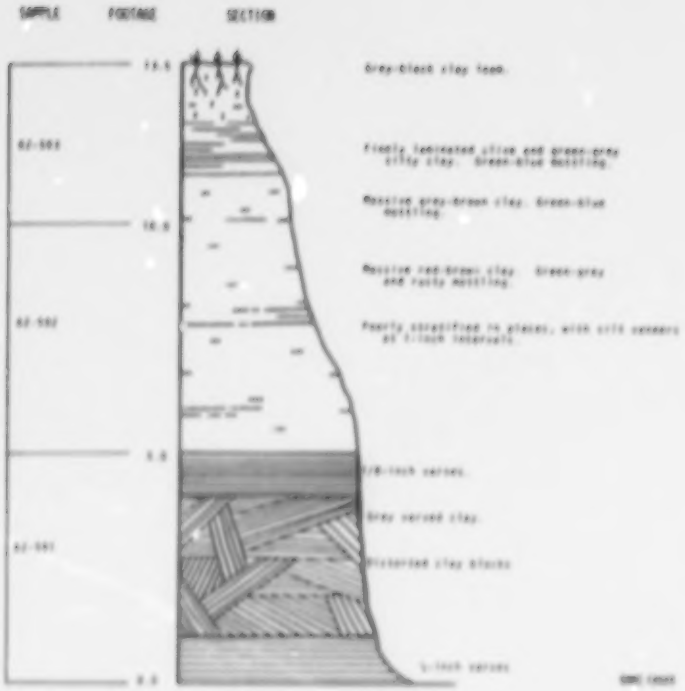


Figure 15 – Varved clay near Coldwater.

Figure 16 – Clay section near Uhthoff.

above and below is horizontal and apparently undisturbed.

UHTHOFF (20)

A similar clay section to that observed at Coldwater appears to occupy the broad flood plain of the North River. An exposure in the river bank at the northeast corner of lot 15, concession VI Orillia Township is illustrated in Figure 16. Unlike the Coldwater site this exposure is not deep enough to expose the varved clay that probably underlies the flood plain clays. Two samples were taken as follows.

Sample 62-570: The top 1 m (3½ feet) section consists of uniformly stratified brown clay and buff silt, drying buff and pale grey respectively. Stratification is less obvious near the top and grades into a brown-black loamy topsoil.

Sample 62-569: The lower 1 m (3 feet) of the bank consist of massive, smooth, blocky, tough brown clay mottled grey-blue and rusty. The clay dries pale grey-brown and contains a few fine roots and rare gneissic pebbles.

LINDSAY (21)

Shallow patches of stoneless clay washed from till into low ground and flood plains in the Lindsay area provide little potential for clay products. A typical exposure was sampled in a field 0.4 km (¼ mile) east of the junction of Highways 7 and 35 North. A shallow excavation for a water hole for cattle gave access to the clay.

Sample 63-646: One metre (3 feet) of olive-grey silty clay and pale grey silt, topped by a few inches of black loam, contain a few recent shells and fine roots but no stones.

BRACEBRIDGE (22)

A thick sequence of varved clay occurs on the west bank of the North Muskoka River in Macaulay Township, 3 km (2 miles) north of Bracebridge. The terrain is flat open farmland for 0.8 km (½ mile) west of the river and for at least 1.6 km (1 mile) along its length. The section is illustrated in Figure 17. Four samples were taken from the exposed section in the upper half of the 18 m (60 feet) bank as follows.

Sample 62-618: The upper 2 m (7½ feet) of thinly varved clay of which the clay fraction comprises about one-third.

Sample 62-617: The middle 3 m (9 feet) of uniformly varved clay of which the clay fraction comprises about 40 percent.

Sample 62-616: The lower 2 m (7 feet) consists of varved clay in couplets decreasing in thickness from 2.5 -3.7 cm (1-1½ inches) at the base to 1.2 cm (½ inch) at the top. Smooth brown clay comprises 25 percent of the unit, pale green-grey silt the rest. Pebbles of Precambrian rock are rarely present.

Sample 62-618A: A composite of the previous three samples.

DORSET (23)

A small bulk sample from an unknown location in the Dorset area was submitted for testing by Mr. John Low.

Sample 63-647: A small bulk sample of greenish-grey silty clay.

HUNTSVILLE (24)

A deposit of varved silt containing almost no clay, and hence of low plasticity, occupies a narrow flat-bottomed ravine between high granite ridges at Melissa in Chaffey Township, 10 km (6 miles) north of Huntsville. An attempt to develop the deposit in the late 1960's as an additive to Portland cement, and as a filler and ceramic material for off-colour products, was unsuccessful. A small pit 300 m (1,000 feet) east of Highway 11 gave access to a 2 m (6 feet) bank for sampling. The pit floor is about 3 m (10 feet) above the level of the Little East River that crosses the property 60 m (200 feet) to the south. The silt is topped by several feet of brown sand and stones.

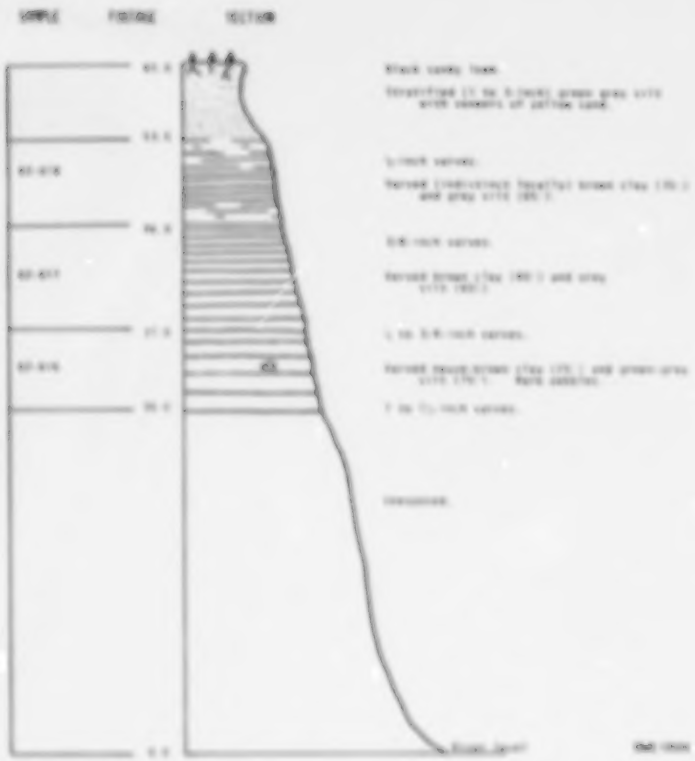


Figure 17 – Varved clay near Brassbridge.

Figure 18 – Lake Erie shore at Port Dover.

Figure 19 – Clay section at Port Rowan.

Sample 62-615: The 2 m (8 feet) bank consists of varved olive-grey silt and veneers of fine grey sand decreasing in thickness from 1.9 cm (3/4 inch) at the base to 0.6 m (¼ inch) at the top. A faint stratification is apparent within the varves. The silt is stoneless and rootless but contains rare rusty mottlings and joint planes.

PORT DOVER (26)

A thick sequence of stoneless clay is exposed on the Lake Erie shore in Woodhouse Township 1.8 km (1 mile) west of Port Dover. The shorecliff section is illustrated in Figure 18. Four samples were taken as follows.

Sample 63-630: An upper 1 m (4 feet) section of brown silty clay is mottled with rusty spots and has a faint platy lamination.

Sample 63-629: A middle section of 8 m (25 feet) thickness consists of mostly massive brown silty clay with occasional thin stratification.

Sample 63-628: The lower 6 m (20 feet) of the bank comprises thick-bedded (20-25 cm; 8-10 inches) yellow brown silt decreasing to 2.5-5 cm (1 or 2 inches) at the top, marked by thin interbeds of dark brown clay. The unit contains occasional limestone pebbles.

Sample 63-630A: A composite of the previous three samples.

PORT ROWAN (26)

The 5 m (17 feet) pit face of the former Port Rowan Brick and Tile Company on lot 17 concession A South Walsingham Township, Norfolk County, was still accessible for sampling in 1962. The section is illustrated in Figure 19. Two samples were taken as follows.

Sample 62-587: The top 1 m (4½ feet) consists of thinly laminated yellow-brown and pale sandy clay, grading upwards into dark brown loamy clay with numerous pea-sized white lime concretions.

Sample 62-586: The lower 2 m (6½ feet) consists of massive brown silty clay with a few thin lenses of buff sand, grading upwards into irregularly stratified (1.2-7.6 cm; ½-3 inch beds) buff fine sand and brown clay, which in turn gives way to massive, brown, blocky, stoneless, silty clay at the top.

Clays of Southwestern Ontario

Nowhere in Canada has there been such a profusion of brick and tile yards than in Southwestern Ontario. Baker (1906) describes sixty-eight, and his list was by no means exhaustive. It is the more surprising because the availibility of suitable clay is so limited. Stony tills predominate, and only in the top several feet, or in recent shallow flood plains, is there clay free of stones.

While many of the yards also made bricks at the outset, drainage tile became the mainstay of the industry. Because Southwestern Ontario is largely agricultural there was, and continues to be, a great demand for drainage tile to improve the predominantly heavy clay soils. Many old tile yards continue to survive with a minimum of modernization, but the advent of perforated plastic pipe in recent years has been providing overwhelming competition. Today there are fewer tile yards in Southwestern Ontario than there has ever been during the past century, but it is interesting to note signs of a resurgence in clay tile-making as a result of the sharply increasing cost of plastics related to the rising prices of all petroleum products.

While the clay sources were shallow and often stony, their ceramic properties were usually improved by the leaching and weathering that had taken place in the surface layer. And because the modest production levels of these plants did not require great volumes of clay, such limited sources proved adequate both as to quality and quantity.

Most of the Southwestern Ontario clays are derived from tills by relatively recent processes. Either they have been washed from upland till areas and concentrated in stratified flood plain deposits, or they have developed in situ by the sifting and sorting action of late glacial lake waters, resulting in the settling of stones to greater depths in the clay profile.

The clays described on the following pages were mostly taken from abandoned tile yards. Their chemical, mineralogical, and ceramic properties are given in Tables 20, 21 and 22.

SAMPLE DESCRIPTIONS FOR TABLES 30, 31 AND 32

63-655: *Brownsville* (37); new pit *of* Dellor's Tile Ltd.; 6 feet (2 m) *of* tough brown clay.
63-645: Lyons (28); 6 miles (10 km) north *of* Aylmer on west side *of* Highway 73; 3 feet (1 m) *of* brown clay.
63-644: McNaurton (29); roadcut on south bank *of* Big Monday Creek; 4 feet (1 m) *of* brown clay and silt.
63-643: Highgate (30); abandoned tile yard 1 mile (1.6 km) southeast *of* Highgate; 3½ feet (0.8 m) *of* gritty clay.
63-642: Warwick (31); abandoned tile yard at Kingarvort, 4 miles (6 km) southwest *of* Warwick; 3½ feet (1 m) *of* brown clay.
63-570: Crediton (32); west bank *of* Ausable River, east *of* Crediton; top 3½ feet (1 m) *of* sandy brown clay.
63-577: Crediton (32); location as above; underlying 3½ feet (1 m) *of* stratified clay and sand.
63-576: Crediton (32); location as above; bottom foot *of* brown silty clay.
63-579: Crediton (32); east bank *of* river; 2½ feet (0.8 m) *of* loamy brown clay.
63-650: St. Joseph (33); abandoned brickyard on north bank *of* creek 1¼ miles (2 km) southeast *of* St. Joseph; 3 feet (1 m) *of* sandy clay.
63-657: Brunsilber (34); abandoned tile yard; 5 feet (1.5 m) *of* laminated clay and silt.
63-650: Lucknow (35); abandoned tile yard at St. Helen, 5 miles (9 km) south *of* Lucknow; 4½ feet (1.4 m) *of* silty clay.
63-562: Seaforth (36); abandoned tile yard on south bank *of* Bayfield River; 5 feet (1.5 m) *of* brown clay and silt.
63-661: Dublin (37); abandoned tile yard on river bank 1¼ miles (2 km) southwest *of* Dublin; top 4 feet (1.2 m) *of* tough brown clay.
63-660: Dublin (37); location as above; lower 7 feet (2 m) *of* tough mottled clay.
63-659: Mitchell (38); abandoned brick yard; 3 feet (1 m) *of* mottled grey and rusty silty clay.
63-663: Stratford (39); abandoned brick yard in south outskirts *of* Stratford; 2 feet (0.8 m) *of* mottled brown clay.
63-664: Stratford (39); drainage ditch on Highway 19, 4 miles (6 km) northeast *of* Stratford; 4 feet (1 m) *of* sandy grey clay.
63-665: Tavistock (40); abandoned tile yard on the XVth concession road, 2 miles (3 km) southeast *of* town; 2 feet (0.6 m) *of* blue-grey clay.

TABLE 30 CHEMICAL ANALYSES — SOUTHWESTERN ONTARIO CLAYS

Sample No.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	TiO_2 %	CO_2 %	H_2O^+ %	H_2O^- %	SO_3 %	MnO %	Total %	Loss on Ignition %	Soluble Salts %
63-655	65.65	12.19	6.20	11.06	2.67	0.93	2.63	0.51	9.47	2.35	1.61	0.22	—	99.4	13.06	—
63-645	—	—	4.35	10.20	—	—	—	—	—	—	—	—	—	—	13.94	0.60
63-644	—	—	5.06	14.70	—	—	—	—	—	—	—	—	—	—	18.19	0.98
63-643	—	—	7.37	1.53	—	—	—	—	—	—	—	—	—	—	5.99	0.88
63-642	—	—	3.70	13.90	—	—	—	—	—	—	—	—	—	—	20.15	0.97
63-578	—	—	4.38	3.05	—	—	—	—	—	—	—	—	—	—	8.16	0.74
63-577	—	—	2.96	16.10	—	—	—	—	—	—	—	—	—	—	22.29	0.43
63-576	—	—	2.57	20.10	—	—	—	—	—	—	—	—	—	—	26.26	0.30
63-579	—	—	4.36	2.63	—	—	—	—	—	—	—	—	—	—	8.44	0.79
63-650	—	—	4.95	1.52	—	—	—	—	—	—	—	—	—	—	7.58	1.40
63-657	—	—	2.93	14.50	—	—	—	—	—	—	—	—	—	—	20.64	0.69
63-650	—	—	3.60	12.20	—	—	—	—	—	—	—	—	—	—	18.05	0.73
63-562	—	—	3.43	20.60	—	—	—	—	—	—	—	—	—	—	24.17	1.36
63-661	—	—	3.52	16.90	—	—	—	—	—	—	—	—	—	—	23.24	1.20
63-660	—	—	2.83	23.60	—	—	—	—	—	—	—	—	—	—	26.95	0.80
63-659	—	—	3.35	10.90	—	—	—	—	—	—	—	—	—	—	14.07	0.82
63-663	—	—	5.78	1.80	—	—	—	—	—	—	—	—	—	—	7.17	1.20
63-664	—	—	3.70	10.60	—	—	—	—	—	—	—	—	—	—	17.07	1.94
63-665	—	—	4.68	2.66	—	—	—	—	—	—	—	—	—	—	6.52	0.66

TABLE 21 MINERAL ANALYSES – SOUTHWESTERN ONTARIO CLAYS

Sample No.	Non-clay minerals: Quartz	Calcite	Dolomite	Soda-lime feldspar	Potash feldspar	Amphibole	Clay minerals: Illite	Chlorite	Expanding mineral
	%	%	%	%	%	%			
63-656	20	19	3	4	1	ND	A	C	C
63-585	20	13	6	4	1	ND	B	C	B (IM)
63-584	19	20	4	2	1	ND	A	B	C
63-583	46	ND	ND	2	1	ND	A	C	B (I)
63-582	24	12	15	1	1	ND	B	C	C (I)
63-570	33	ND	4	3	1	1	A	B	B
63-577	19	10	33	1	1	ND	A	C	C (MI)
63-576	22	13	32	2	1	ND	B	C	C (I)
63-579	37	3	6	2	1	1	A	C	C (I)
63-556	31	ND	1	2	1	ND	A	C	C (I)
63-557	29	9	20	2	1	ND	B	C	C (I)
63-558	29	7	19	2	1	ND	B	C	B (MI)
63-562	19	19	16	2	1	ND	A	C	ND
63-561	24	22	19	1	1	ND	B	C	D
63-560	21	29	16	1	1	1	A	C	ND
63-559	21	9	17	1	2	1	B	C	B (MI)
63-563	33	ND	1	4	1	ND	A	C	B (I)
63-564	24	5	16	4	1	ND	C	C	B (M)
63-565	34	1	2	4	1	ND	A	C	C (I)

(M = Montmorillonite; I = Interlayered)
(A = Abundant; B = Moderate; C = Minor; D = Trace; ND = Not detected).

TABLE 37 CERAMIC PROPERTIES — SOUTHWESTERN ONTARIO CLAYS.

Sample	% Water of plasticity	% Drying Shrinkage	PCE	Fired Characteristics								
				Cone*	% Firing Shrinkage**	% water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
65-655	26	5.9	2-3	010	0.7	17.1	17.6	1.76	Salmon	Hard	Smooth textured and attractive.
				06	1.1	15.5	16.4	1.77	Tan	Hard	
				03	2.5	10.5	11.1	1.88	Tan	Very hard	
62-585	20	5.3	—	010	0.0	20.0	21.7	1.73	Salmon	Almost hard	Abundant lime pops.
				06	+0.3	17.1	20.6	1.73	Salmon	Almost hard	
				03	2.1	10.0	16.0	1.85	Yellow-brown	Very hard	
62-584	27	6.3	3	010	2.8	16.4	17.1	1.77	Tan	Almost hard	Abundant lime pops.
				06	3.2	15.8	16.4	1.79	Cream-buff	Very hard	
				03	14.0	4.0	4.3	2.30	Green	Very hard	
62-583	21	5.4	7	010	0.7	11.3	13.1	1.96	Salmon	Hard	Attractive at the lower cones.
				06	2.6	8.6	11.3	2.04	Red	Very hard	
				03	6.0	0.9	1.3	2.31	Dark red	Very hard	
62-582	22	5.3	6	010	0.3	21.3	22.5	1.65	Pink tan	Almost hard	Occasional lime pops.
				06	0.0	18.0	21.1	1.63	Cream	Almost hard	
				03	0.7	16.7	22.6	1.66	Buff	Hard	
62-578	24	6.6	5	010	0.4	14.8	16.0	1.84	Salmon	Almost hard	Good quality.
				06	0.9	13.8	14.8	1.87	Dark salmon	Almost hard	
				03	6.4	2.7	3.2	2.23	Red-brown	Very hard	
62-577	19	4.6	7	010	+0.5	22.7	24.3	1.62	Cream-pink	Almost hard	Occasional lime pops.
				06	+0.3	22.5	24.3	1.58	Cream	Almost hard	
				03	+0.3	19.6	24.3	1.57	Cream-buff	Almost hard	
62-576	17	4.2	6-7	010	+1.6	31.5	34.6	1.44	Cream	Rather soft	Smooth textured and attractive.
				06	+3.8	31.6	37.0	1.37	Cream	Rather soft	
				03	+4.5	28.7	38.2	1.32	Cream	Rather soft	
62-579	23	6.5	5-6	010	0.2	14.3	16.1	1.85	Salmon	Hard	Good except for some lime pops.
				06	0.5	13.0	15.5	1.86	Dark salmon	Hard	
				03	5.0	4.2	8.2	2.11	Red-brown	Very hard	
62-556	24	6.4	6	010	0.4	14.3	15.8	1.86	Salmon	Almost hard	Good quality.
				06	2.5	10.3	11.9	2.01	Salmon-red	Hard	
				03	0.2	4.2	1.4	2.36	Dark red	Very hard	
62-557	19	5.1	7-8	010	+0.4	23.0	25.0	1.62	Tan	Almost hard	Good except for slight streakiness.
				06	+1.2	20.9	26.1	1.57	Cream	Almost hard	
				03	+0.9	17.6	25.4	1.59	Cream-white	Hard	
62-558	17	4.6	5	010	+0.9	22.5	25.0	1.66	Dark salmon	Rather soft	Occasional lime pops and streakiness.
				06	+1.1	19.2	23.9	1.57	Salmon-pink	Rather soft	
				03	+0.4	11.4	20.5	1.72	Yellow-buff	Hard	
62-562	19	4.6	5-6	010	0.0	24.5	26.0	1.56	Pink-tan	Rather soft	Abundant lime pops.
				06	+0.9	23.0	27.0	1.52	Pink-buff	Rather soft	
				03	+1.1	21.4	28.5	1.50	Yellow-buff	Almost hard	
62-561	22	5.2	5-6	010	1.4	22.4	23.2	1.60	Light salmon	Rather soft	Occasional lime pops.
				06	0.5	21.5	24.2	1.55	Cream-pink	Rather soft	
				03	0.4	21.8	27.2	1.54	Cream-buff	Rather soft	

Table 22 continued: CERAMIC PROPERTIES — SOUTHWESTERN ONTARIO CLAYS

				Fired Characteristics							
	% Water of plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	% water Absorption 24-hr. cold	% water Absorption 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-560	20	4.7	8	010	+0.4	31.2	31.8	1.47	Cream-tan	Soft	Attractive except for lime pops.
				06	+1.4	29.5	31.6	1.41	Cream	Rather soft	
				03	+1.9	27.0	33.2	1.39	Cream-buff	Rather soft	
62-559	20	4.8	4	010	+0.7	21.6	24.7	1.61	Light salmon	Rather soft	Occasional lime pops.
				06	+1.4	20.1	25.9	1.56	Tan	Rather soft	
				03	+1.4	18.6	26.4	1.59	Tan-buff	Almost hard	
62-563	25	7.2	6-7	010	1.4	12.7	14.4	1.90	Dark salmon	Almost hard	Fairly attractive.
				06	3.0	9.3	11.6	2.00	Red-brown	Almost hard	
				03	6.8	1.0	1.5	2.32	Dark red-brown	Very hard	
62-564	24	4.0	6	010	+1.1	31.0	34.3	1.42	Pink-tan	Soft	Abundant lime pops.
				06	+1.4	26.6	32.4	1.44	Tan	Soft	
				03	+0.5	22.3	31.5	1.48	Yellow-buff	Rather soft	
62-565	24	7.4	5-6	010	0.0	12.9	14.2	1.87	Salmon	Almost hard	Smooth textured and attractive.
				06	0.2	11.3	13.7	1.89	Pink-salmon	Almost hard	
				03	6.1	1.6	2.2	2.26	Dark brown	Very hard	

*Equivalent temperatures measured by optical pyrometer: Cone 010 (1660°F), cone 06 (1940°F), cone 03 (1960°F).
**A plus (+) sign indicates expansion.

BROWNSVILLE (27)

Deller's Tile Limited, located south of Brownsville in Dereham Township and 13 km (8 miles) west of Tillsonburg, opened a new clay pit in 1962 giving access to a 2.4 m (8 feet) section. The pit is located 0.4 km (¼ mile) west of the plant just north of the Michigan Central Railway track. A 2 m (6 feet) sample was taken from the bank, beneath 0.3 m (1 foot) of medium to coarse grained yellow sand and a 0.3 m (1 foot) of black loam topsoil.

Sample 65-655: Two metres (6 feet) of tough stoneless brown clay mottled with rust and grey, massive near the top with fine wavy laminations near the base.

The floor of the pit is at the limit of oxidation. The clay below is blue-grey and contains lenses of silt to several inches thick. It was said to burn to a porous and chalky body, and hence was not used in the making of tile.

LYONS (28)

An abandoned clay pit on the west side of Highway 73 10 km (6 miles) north of Alymer gave access to a 1 m (3 feet) clay bank. The former plant of W. McCredie produced salmon-coloured bricks, drain and wall tiles on this site prior to 1940. Numerous shallow excavations occur over a wide area, principally in lot 13, concession IX, South Dorchester Township. The general terrain is low and hummocky. Stoneless clays are confined to shallow deposits in low ground between areas of till.

Sample 62-585: One metre (3 feet of dark brown silty clay with occasional pebbles is loamy at the top and grades downwards through a mottled olive-grey and rusty-yellow sandy clay into fine yellow sand at the base.

MELBOURNE (29)

Construction of a new bridge over Big Monday Creek on concession III of Ekfrid Township, 5 km (3 miles) south of Melbourne, gave access to a 1 m (4 feet) section of stoneless clay overlying till. The section is illustrated in Figure 20.

Sample 62-584: A 1 m (4 feet) section consists of irregularly and thinly stratified medium brown clay and pale brown silt becoming massive and blocky near the top.

HIGHGATE (30)

The abandoned pit belonging to the former tile yard of Norman McEachern and Sons in concession IV, Orford Township, Kent County, 2 km (1 mile) or so southeast of Highgate, gave access to a shallow clay section. The plant produced red drain tile until about 1940.

Sample 62-583: A 0.8 m (2½ feet) section of mottled grey and brown clay is loamy at the top, but otherwise is rather tough, blocky, massive, stoneless and gritty.

KINGSCOURT (31)

The former McCormick tile yard at Kingscourt, 6 km (4 miles) southwest of Warwick in concession IV of South Warwick Township, gave access to a 1 m (3½ feet) section of clay as illustrated in Figure 21. A drainage ditch adjoining the old pit workings exposed till to a depth of 1.5 m (5 feet) below the pit floor.

Sample 62-582: A 1 m (3½ feet) section consists of laminated silty clay overlying till at the base, in sharp contact with massive and blocky mauve-brown clay with rusty and green-grey mottlings, becoming loamy at the top.

CREDITON (32)

The banks of the Ausable River east of Crediton in Stephen Township were the site of a number of early tile yards, the last of which closed about 1940. The old clay workings on the former Kerr property gave access to a 3 m (10 feet) section as illustrated in Figure 22. These samples were taken from this exposure on the

Figure 20 – Clay section at Melbourne.

Figure 21 – Clay section at Kingaroy.

Figure 22 – Clay section at Crediton.

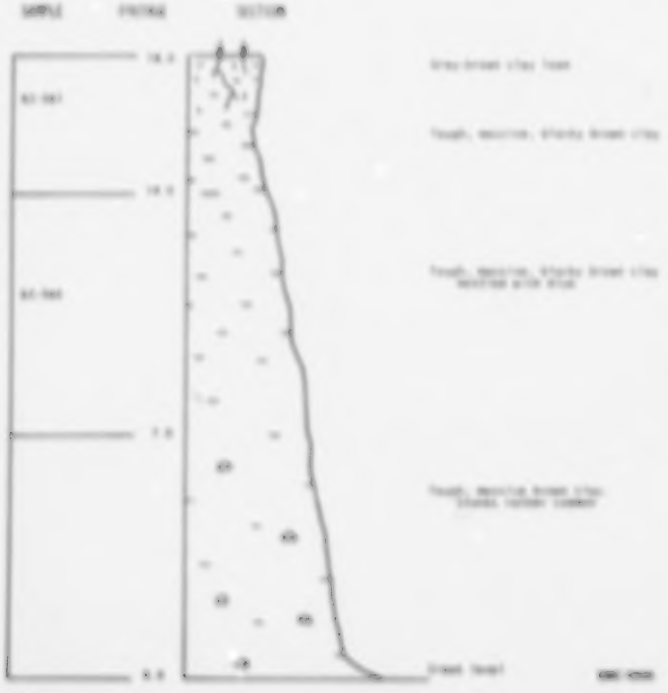


Figure 23 – Clay section at Dublin.

west side of the river. A fourth sample was taken near the barn on the east side of the river where the clay was said to be red-burning. A well sunk at the barn was said to be in similar clay to a depth of 7 m (23 feet).

Sample 62-578: The top 1 m (3½ feet) of the 3 m (10 feet) bank consists of massive brown sandy clay with mottlings of rust and blue-green. The clay is stoneless, but fine roots are common.

Sample 62-577: The underlying 1 m (3½ feet) is irregularly stratified fine buff-grey sand and strong brown clay.

Sample 62-576: The lower 1 m (3 feet) of the bank is unexposed, and this sample was dug from the floor of the pit. It consists of pale brown silty clay of low plasticity, poorly stratified at 0.6-1.2 cm (¼-½ inch), that dries to a soft chalky grey colour.

Sample 62-579: The top 0.8 m (2½ feet) of mottled brown sandy clay exposed in a shallow trench on the east side of the river near the barn.

ST. JOSEPH (33)

An abandoned brickyard on the farm of M.L. Jeffrey in Hay Township, 2 km (1¼ miles) southeast of St. Joseph, gave access to 1 m (3 feet) of clay over till. Foundations of the old plant are now barely visible, but the pit workings covered an area of several acres on the north side of a creek.

Sample 62-556: A 1 m (3 feet) section of mottled grey and brown unstratified sandy clay containing an occasional pebble grades upwards into dark brown clay loam.

BENMILLER (34)

Drain tile was produced by the Kerr family at Benmiller in Colborne Township, 8-10 km (5-6 miles) east of Goderich, until 1940 when the plant was closed. The clay pit occupies a slight depression between higher areas of till.

Sample 62-557: 1.5 m (5 feet) of finely stratified grey-brown stoneless clay and yellow silt, loamy at the top and passing into unoxidized grey clay at depth.

ST. HELEN (35)

The abandoned workings of a former tile yard can still be seen on the farm of A.E. Durnin at St. Helen, 8 km (5 miles) south of Lucknow. Located on the north side of St. Helen Creek the plant was operated for about 40 years, closing finally in 1936. The clay pit occupies a very restricted valley between hills of till. Lenses of fine gravel occur in places in the floor of the pit.

Sample 62-558: A section of 1.3 m (4½ feet) of mottled blue-grey, brown, and rusty yellow silty clay, weakly stratified, and containing occasional shells and limestone pebbles, grades into grey silt and sand at the base, and into brown clay loam at the top.

SEAFORTH (36)

A former tile yard worked by three generations of the Sproat family was finally closed about 1955. The workings are on the south side of the Bayfield River in Tuckersmith Township, Huron County, about 5 km (3 miles) southeast of Seaforth. A 1.5 m (5 feet) section was sampled at the north end of the clay pit.

Sample 62-562: Coarsely stratified (5-30 cm; 2-12 inches) brown clay mottled with blue and interlayered with thin laminated beds of rusty yellow silt. The clay is tough, dense, blocky, and stoneless, and is loamy with a few fine roots at the top.

DUBLIN (37)

The former tile yard of W.W. Sadler is located on the south side of the Bayfield River in Hibbert Township, Perth County, 3 km (2 miles) south of Dublin. The upper part of a 5 m (18 feet) bank of the river near the old pit was sampled. The bottom 2 m (7 feet) of the bank contains limestone pebbles and was not sampled. The section is illustrated in Figure 23.

Sample 62-561: The top 1 m (4 feet) of the bank consists of massive, tough, dark

brown stoneless clay, loamy at the top. Sample 62-560: The underlying 2 m (7 feet) section is medium brown stoneless clay mottled with blue and dark brown. It is tough, blocky, massive and uniform, but contains pebbles in increasing numbers at greater depths.

MITCHELL (30)

A tile yard at Mitchell in Perth County, long since abandoned, is marked only by a shallow clay pit covering several acres to a depth of 1-1.5 m (3-5 feet).

Sample 62-559: One metre (3 feet) of silty clay, grey mottled with rusty yellow, stoneless, and with a few fine roots, grades upwards into brown clay loam.

STRATFORD (29)

Stratford is the locale of a number of abandoned tile yards, all of which utilized a very thin stonefree veneer of clay in predominantly till terrain. Typical of these is the site of a former tile yard on the John Wray farm on the south side of Stratford. The pit is marked by shallow diggings over a 2.4-3.2 hectare (6-8 acres) area south of the railway and beneath the powerline. The 1 m (2 or 3 feet) bank was sampled as follows.

Sample 62-563: A 0.6 m (2 feet) section consists of mottled grey and brown clay loam becoming dense, tough, and blocky in the lower foot and bottoming in stony clay (till). Fine roots and occasional stones are also present in the sampled portion.

A drainage ditch on the east side of Highway 19, 6 km (4 miles) northeast of Stratford exposes a 1 m (4 feet) clay section overlying till.

Sample 62-564: A 1 m (4 feet) section consists of 0.6 m (2 feet) of grey sandy clay mottled with rusty yellow, and containing occasional stones, grading upwards into olive-grey stoneless silty clay topped by 15 cm (6 inches) of loamy black organic topsoil.

TAVISTOCK (40)

An abandoned tile yard is located on the concession XV of East Zorra Township, 3 km (2 miles) southeast of Tavistock.

Sample 62-565: A 0.6 m (2 feet) section consists of dense, tough, stoneless, blue-grey clay mottled with rusty brown.

Clays of Northeastern Ontario

The most characteristic stoneless clays of Northeastern Ontario are the varved clays that were deposited along the east shore of Georgian Bay, along the north shore of Lake Huron, and on the flank of the height of land in the central part of the region.

Lake Algonquin first occupied the Lake Huron basin 12,500 years ago in the wake of the receding ice. By 12,000 years ago it had reached its maximum elevation, and thereafter through a sequence of fluctuating lake levels a series of Post-Algonquin lakes occupied the Huron basin, culminating in the Nipissing Great Lakes of 6,000 years ago (Prest 1970, p.716-731). Varved clays are characteristic of the Lake Algonquin deposits, formed when the melting glacier was still near, and abundant sediment was entering the lake. Stratified (non-varved) clays are more typical of Post-Algonquin lake stages when the melting ice-front was more remote.

Similarly, varved clay was deposited in Lake Barlow-Ojibway starting about 10,000 years ago and lasting about 2,000 years. This lake, of which Lake Abitibi is a remnant, was ponded against higher land by the melting ice-front which formed its gradually receding north shore.

While these events account for most of the Northeastern Ontario clay deposits, others are more recent in origin and are a result of reworking of these as well as nearby glacial tills. Such clays occupy the flood plains of today's rivers, or shallow depressions in undulating till terrain.

The clays of Northeastern Ontario are generally limy and of marginal interest for clay products. Although they have not been extensively tested, available information suggests they are poorly suited for expanded aggregate.

SAMPLE DESCRIPTIONS FOR TABLES 33, 34 AND 35

62-594: Parry Sound (41); north of the dam on the west side of Mill Lake; 2 feet (0.6 m) of red brown clay.
63-621: Shebeshekong River (42); Carling Tp. northwest of Parry Sound; composite of four samples of brown clay.
63-622: Shebeshekong River (42); location as above; composite of seven samples of gritty brown clay.
63-623: Shebeshekong River (42); location as above; silty grey clay.
62-614: Powassan (43); roadcut lot 27, con. VIII, South Himsworth Tp.; 10½ feet (3 m) of varved clay.
62-611: Sturgeon Falls (44); creek bank north side of Highway 17, 6 miles (10 km) west of Sturgeon Falls; top 6 feet (2 m) of coarsely varved clay.
62-610: Sturgeon Falls (44); location as above; lower 7 feet (2 m) of varved clay.
65-661: River Valley (45); location unknown; small bulk samples of sandy grey clay.
65-660: Creighton (46); location unknown; small bulk sample of brown clay.
62-609: Whitefish (47); creek bank south side of Highway 17, ¼ mile (0.9 km) east of Whitefish; upper 3 feet (1 m) of laminated brown clay and silt.
62-608: Whitefish (47); location as above, lower 9 feet (3 m) of laminated brown clay and silt.
62-607: Webbwood (48); south bank of Birch Creek, Highway 17, a mile (1.6 km) west of Webbwood; upper 10 feet (3 m) of stratified silt.
62-606: Webbwood (48); location as above; middle 11 feet (3.3 m) of grey varved clay.
62-605: Webbwood (48); location as above; lower 9 feet (2.7 m) of grey coarsely varved clay.
62-575: Sandfield (49); 2½ miles (4 km) south of Sandfield, Manitoulin Island; 3¼ feet (1 m) of brown silty clay.
62-574: Tehkummah (50); creek bank 2 miles (3 km) southwest of Tehkummah, Manitoulin Island, 3¼ feet (1 m) of grey silty clay.
62-604: Thessalon (51); Livingstone Creek bank, Highway 17, 8 miles (13 km) east of Thessalon; upper 4½ feet (1.4 m) of laminated silt.
62-603: Thessalon (51); location as above; middle 8 feet (2 m) of uniformly varved brown clay.
62-602: Thessalon (51); location as above; lower 3 feet (0.9 m) of stratified grey silt.
62-598: St. Joseph Island (52); at Green Point, northwest end of St. Joseph Island, 2 feet (0.6 m) of red brown clay.
62-597: Turbutt (53); creek bank on Highway 17 north of St. Joseph Channel; top 2½ feet (0.8 m) of loamy brown clay.
62-596: Turbutt (53); location as above; middle 4½ feet (1.5 m) of mottled grey and brown clay.
62-595: Turbutt (53); location as above; bottom 4½ feet (1.5 m) of sticky red clay.
62-597A: Turbutt (53); location as above; composite of the previous three samples.
62-601: Bar River (54); roadcut at junction of Calebaugie Road and Highway 17; top 8 feet (2 m) of laminated red clay.
62-600: Bar River (54); location as above; middle 5 feet (1.5 m) of olive brown silty clay.
62-599: Bar River (54); bottom 5 feet (1.5 m) of stratified red and brown clay.
62-555: Earlton (55); Wanstead Creek bank 4 miles (6 km) southwest of Earlton; top 9 feet (2.7 m) of brown varved clay and silt.
62-554: Earlton (55); location as above; next 11 feet (3.3 m) of grey varved clay and silt.
62-553: Earlton (55); location as above; next 21 feet (6 m) of coarsely varved grey silt and minor clay.
62-552: Earlton (55); location as above; bottom 10 feet (3 m) of varved clay and silt.
62-555A: Earlton (55); location as above; composite of previous four samples.
62-551: Matheson (56); creek bank near road 2 miles (3 km) north of Matheson; 3½ feet (1 m) of brown varved clay and silt.
62-550: Matheson (56); location as above; lower 6½ feet (2 m) of massive brown clay.
62-549: Matheson (56); roadside drainage ditch near the same location; bottom 3 feet (1 m) of grey varved clay.
62-543: Moose Lake (57); east shore of Moose Lake, 2 miles (3 km) south of Highway 101; upper 5 feet (1.5 m) of brown varved clay.
62-542: Moose Lake (57); location as above; middle 9 feet (3 m) of grey varved clay.
62-541: Moose Lake (57); location as above; bottom 7 feet (2 m) of coarsely varved grey clay.
62-543A: Moose Lake (57); location as above; composite of previous three samples.
62-544: Nighthawk Lake (58); Lakeshore at southeast end of the peninsula, Highway 803; 10 feet (3 m) of brown varved clay.
62-546: Iroquois Falls (59); Abitibi River bank at the bridge ½ mile (0.9 km) north of Iroquois Falls; upper 4 feet (1 m) of clay and silt.
62-545: Iroquois Falls (59); location as above; lower 9 feet (3 m) of stratified brown clay and silt.
63-625: Abitibi River; 3 feet (1 m) of blue grey clay; lot 15, con.I Knox Tp.
63-626: Abitibi River; 2 feet (0.6 m) of pale brown plastic clay; lot 9, con.V Knox Tp.
63-627: Abitibi River; 4 feet (1.2 m) of brown plastic clay; lot 3, con.VI Rickard Tp.
63-654: Lake Abitibi (60); Kerns Township at the west end of Lake Abitibi; 6 feet (2 m) of brown plastic clay.
62-548: Abitibi Road (61); 1000 feet (300 m) east of the mileage 34 marker on the Abitibi Road; 7½ feet (2.2 m) of olive-grey clay.
62-547: Abitibi Road (61); 700 feet (210 m) east of the mileage 47 marker on the Abitibi Road; 5 feet (1.5 m) of brown varved clay.
62-540: Buskegau River (62); river bank west of Cochrane on Highway 11; upper 5 feet (1.5 m) of brown till.
62-539: Buskegau River (62); location as above; lower 7 feet (2 m) of dense grey till.
62-538: Kapuskasing (62); west bank of Kapuskasing River 2 miles (3 km) southwest of Kapuskasing; 7 feet (2 m) of brown clay and silt.
62-537: Hearst (64); roadcut on Highway 583 at the southern limits of Hearst; 3 feet (1 m) of brown laminated clay.

TABLE 23 CHEMICAL ANALYSES — NORTHEASTERN ONTARIO CLAYS

Sample No.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	TiO_2 %	CO_2 %	H_2O^+ %	H_2O^- %	SO_3 %	MnO %	Total %	Loss on Ignition %	Soluble Salts %
63-596	—	—	6.40	1.86	—	—	—	—	—	—	—	—	—	—	5.80	1.02
63-621	—	—	6.20	2.01	—	—	—	—	—	—	—	—	—	—	5.52	1.40
63-622	—	—	5.85	2.03	—	—	—	—	—	—	—	—	—	—	5.71	1.09
63-623	—	—	3.43	2.30	—	—	—	—	—	—	—	—	—	—	4.52	1.10
63-614	—	—	3.59	2.56	—	—	—	—	—	—	—	—	—	—	2.83	0.65
63-611	—	—	4.26	6.23	—	—	—	—	—	—	—	—	—	—	6.36	1.14
63-610	—	—	6.11	8.94	—	—	—	—	—	—	—	—	—	—	12.77	0.79
65-661	—	—	2.47	4.52	—	—	—	—	—	—	—	—	—	—	4.06	0.99
65-660	—	—	4.05	1.83	—	—	—	—	—	—	—	—	—	—	2.96	0.78
63-609	—	—	6.87	1.58	—	—	—	—	—	—	—	—	—	—	6.34	1.15
63-608	—	—	5.57	1.87	—	—	—	—	—	—	—	—	—	—	4.96	1.19
63-607	—	—	4.26	3.26	—	—	—	—	—	—	—	—	—	—	4.30	0.70
63-606	—	—	3.73	6.27	—	—	—	—	—	—	—	—	—	—	9.45	0.51
63-605	—	—	3.10	6.80	—	—	—	—	—	—	—	—	—	—	7.01	0.83
63-575	—	—	4.55	4.85	—	—	—	—	—	—	—	—	—	—	9.64	0.74
63-574	—	—	2.85	7.45	—	—	—	—	—	—	—	—	—	—	13.61	0.81
63-604	—	—	4.21	1.98	—	—	—	—	—	—	—	—	—	—	3.30	1.03
63-603	—	—	5.21	1.27	—	—	—	—	—	—	—	—	—	—	4.66	1.09
63-602	—	—	3.48	2.33	—	—	—	—	—	—	—	—	—	—	2.33	0.93
63-598	—	—	5.21	5.10	—	—	—	—	—	—	—	—	—	—	9.08	1.01
63-597	—	—	4.98	1.62	—	—	—	—	—	—	—	—	—	—	5.43	1.29
63-596	—	—	6.02	4.69	—	—	—	—	—	—	—	—	—	—	10.26	1.26
63-595	—	—	5.82	8.24	—	—	—	—	—	—	—	—	—	—	13.02	1.22
63-597A	55.1	15.0	5.94	5.77	3.65	1.57	3.39	0.54	4.66	3.02	2.13	Nil	0.08	101.0	9.44	—
63-601	—	—	5.63	7.66	—	—	—	—	—	—	—	—	—	—	12.79	0.90
63-600	—	—	6.43	3.76	—	—	—	—	—	—	—	—	—	—	6.29	1.01
63-599	—	—	5.32	4.72	—	—	—	—	—	—	—	—	—	—	8.92	0.79
63-555	—	—	4.63	9.72	—	—	—	—	—	—	—	—	—	—	13.53	0.64
63-554	—	—	5.09	8.20	—	—	—	—	—	—	—	—	—	—	9.91	1.21
63-553	—	—	3.52	7.47	—	—	—	—	—	—	—	—	—	—	7.41	0.83
63-552	—	—	4.82	7.17	—	—	—	—	—	—	—	—	—	—	9.34	1.24
63-555A	55.4	12.2	4.33	9.11	4.73	2.38	2.22	0.45	7.14	1.62	0.68	Nil	0.07	99.3	9.00	—
63-551	—	—	5.17	10.07	—	—	—	—	—	—	—	—	—	—	15.19	1.00
63-550	—	—	5.75	14.60	—	—	—	—	—	—	—	—	—	—	18.03	1.28
63-549	—	—	3.97	12.20	—	—	—	—	—	—	—	—	—	—	16.07	0.81
63-543	—	—	5.68	7.92	—	—	—	—	—	—	—	—	—	—	12.17	0.84
63-542	—	—	6.05	10.90	—	—	—	—	—	—	—	—	—	—	14.47	0.99
63-541	—	—	4.53	12.20	—	—	—	—	—	—	—	—	—	—	14.93	0.62
63-543A	66.3	12.9	5.54	11.00	4.87	1.72	2.87	0.69	9.46	2.42	1.47	Nil	0.06	99.2	13.74	—
63-544	—	—	3.23	12.00	—	—	—	—	—	—	—	—	—	—	15.30	0.66
63-546	—	—	4.54	13.70	—	—	—	—	—	—	—	—	—	—	17.68	0.80
63-545	—	—	4.53	14.10	—	—	—	—	—	—	—	—	—	—	18.10	0.76
63-635	—	—	4.13	11.40	—	—	—	—	—	—	—	—	—	—	13.95	0.67
63-636	—	—	6.05	11.60	—	—	—	—	—	—	—	—	—	—	16.31	0.68
63-627	42.9	11.9	5.36	14.94	4.52	1.30	2.65	0.52	12.36	2.53	1.93	0.21	0.10	101.3	17.93	—
63-654	—	—	6.61	10.60	—	—	—	—	—	—	—	—	—	—	15.61	1.12
64-569	—	—	6.09	12.30	—	—	—	—	—	—	—	—	—	—	15.82	1.05
63-547	—	—	7.77	4.51	—	—	—	—	—	—	—	—	—	—	10.92	0.76
63-540	—	—	3.62	12.50	—	—	—	—	—	—	—	—	—	—	16.29	0.68
63-539	—	—	3.67	13.50	—	—	—	—	—	—	—	—	—	—	18.48	1.03
63-538	—	—	3.67	17.30	—	—	—	—	—	—	—	—	—	—	19.11	1.20
63-537	—	—	4.79	14.30	—	—	—	—	—	—	—	—	—	—	17.86	1.07

TABLE 24 MINERAL ANALYSES — NORTHEASTERN ONTARIO CLAYS

Sample No.	Non-clay minerals: Quartz	Calcite	Dolomite	Soda-lime feldspar	Potash feldspar	Amphibole	Clay minerals: Illite	Chlorite	Expanding mineral
	%	%	%	%	%	%			
63-594	21	<1	<1	6	1	14	A	C	B
63-631	Not available								
63-632	Not available								
63-633	Not available								
63-614	19	ND	1	15	0	10	A	C	A (I)
63-611	29	1	6	7	0	10	C	A	C
63-619	17	1	5	4	1	14	B	A	C
63-681	28	ND	3	8	0	6	C	A	D
63-600	37	ND	Trace	7	0	3	A	A	C
63-608	33	ND	ND	6	0	3	B	B	A (IM)
63-606	38	ND	ND	1	0	10	A	A	C
63-607	33	1	1	0	0	10	C	B	B
63-606	33	1	1	6	1	15	C	A	C (IM)
63-605	31	0	6	8	0	10	C	A	C
63-670	34	1	6	4	1	10	B	A	C (I)
63-674	38	1	10	6	0	10	C	C	C (IM)
63-604	36	ND	ND	7	0	15	C	B	B
63-603	33	ND	1	6	0	14	A	B	B
63-602	45	1	1	6	0	10	C	A	C
63-685	38	0	0	4	0	3	B	A	B (I)
63-687	30	ND	1	4	0	15	B	B	A (IM)
63-696	19	0	3	3	1	14	B	B	A (IM)
63-695	18	0	4	4	0	10	B	B	B
63-601	17	1	4	4	0	3	B	B	A (IM)
63-600	35	ND	1	5	0	10	B	A	B
63-699	33	0	0	6	0	10	B	A	B (I)
63-666	34	1	6	7	1	15	A	B	C (I)
63-664	31	4	6	7	0	10	B	A	D
63-663	31	4	9	6	0	10	B	A	ND
63-662	35	4	6	6	1	10	B	A	D
63-661	33	3	7	6	0	3	A	B	C (I)
63-660	33	14	7	6	0	ND	A	B	C (I)
63-649	34	14	6	6	0	3	A	A	C (I)
63-645	37	6	6	6	0	3	A	A	C (I)
63-642	34	13	6	6	0	3	A	A	ND
63-641	39	13	6	6	0	3	A	A	D
63-644	39	13	7	6	0	3	A	B	C (I)
63-646	33	16	8	6	0	ND	A	B	C (I)
63-640	36	21	9	6	0	3	A	B	C (I)
63-635	36	11	11	6	0	10	A	A	—
63-636	34	16	6	5	1	14	A	A	C (I)
63-637	36	16	7	6	1	10	A	A	C (I)
63-654	33	13	4	5	1	14	B	A	—
63-649	35	15	6	4	1	3	A	A	C (I)
63-647	31	6	0	5	1	3	A	B	C (I)
63-648	36	17	14	5	1	3	A	B	ND
63-639	39	14	17	5	1	3	B	B	ND
63-629	35	15	13	6	0	3	A	A	ND
63-627	37	17	11	6	1	3	A	B	ND

(M = Montmorillonite, I = Interlayered)
(A = Abundant, B = Moderate, C = Minor, D = Trace, ND = Not detected)

Table 25 : CERAMIC PROPERTIES – NORTHEASTERN ONTARIO CLAYS

Sample	% Water of Plasticity	% Drying Shrinkage	pH	Fired characteristics: Colour	% Firing Shrinkage at 1	% water Absorption: 24-hr cold	% water Absorption: 5-hr boiling	Specific Gravity	Colour	Hardness	Remarks
63-104	31	8.7	6.5	010	2.2	13.1	13.7	1.93	Salmon	Hard	Slight warping
				08	6.6	0.7	1.5	2.23	Salmon red	Very hard	
				03	6.2	0.0	0.1	2.21	Red brown	Very hard	
63-021	27	7.4	7	010	0.7	12.5	13.0	1.85	Pale salmon	Hard	Excellent quality
				08	3.7	9.4	10.0	2.01	Salmon	Very hard	
				03	6.1	0.2	0.5	2.44	Brown red	Very hard	
63-022	28	7.2	5-6	010	0.0	12.7	13.5	1.90	Pale salmon	Hard	Excellent.
				08	2.0	1990.2	11.8	2.00	Salmon	Very hard	
				03	3.6	1.8	2.5	2.35	Brown red	Very hard	
63-030	20	5.7	5	010	0.0	12.2	14.1	1.89	Buff salmon	Almost hard	Good quality.
				08	0.6	11.6	13.5	1.92	Orange salmon	Hard	
				03	3.0	6.5	9.6	2.07	Salmon red	Very hard	
63-010	27	8.0	6	010	0.7	16.6	17.6	1.79	Salmon	Almost hard	Fairly good.
				08	3.6	12.2	13.9	1.92	Salmon red	Hard	
				03	8.9	0.2	0.2	2.24	Dark brown	Very hard	
63-011	23	6.0	6	010	+0.3	23.6	26.5	1.60	Tan	Rather soft	Poor, mottled.
				08	+0.3	23.0	26.4	1.61	Cream tan	Rather soft	
				03	2.6	16.2	19.4	1.73	Pink	Almost hard	
63-010	21	7.8	5-6	010	1.1	23.0	26.0	1.67	Tan	Hard	Poor quality,
				08	1.0	23.0	25.1	1.67	Tan pink	Very hard	mottled and
				03	6.8	13.7	15.3	1.98	Pink red	Very hard	cracked.
63-041	16	1.0	—	010	+1.0	15.1	21.0	1.71	Pinkish tan	Very soft	Warped, poor
				08	+1.0	16.0	23.6	1.67	Pinkish tan	Very soft	quality.
				03	+1.4	16.6	22.2	1.57	Pinkish tan	Very soft	
63-009	23	0.0	6	010	+1.0	—	—	—	Tan	Soft	Poor quality,
				08	+0.7	17.0	19.1	1.72	Tan	Nearly hard	warped.
				03	3.7	8.7	10.2	1.99	Pink salmon	Hard	
63-039	22	7.9	6	010	1.2	16.6	17.8	1.84	Light salmon	Hard	Fair quality.
				08	6.0	10.1	10.8	2.04	Salmon	Very hard	
				03	9.0	0.3	0.7	2.80	Dark brown	Very hard	
63-000	29	0.0	5	010	0.2	17.5	19.2	1.78	Light salmon	Rather soft	Smooth textured,
				08	1.4	14.8	15.6	1.87	Salmon	Almost hard	attractive.
				03	5.1	1.0	1.1	2.47	Dark red	Very hard	
63-007	29	0.0	6	010	+0.1	19.3	20.8	1.73	Salmon	Med. hard	Mottled, chalky,
				08	+0.3	19.1	20.5	1.73	Salmon pink	Med. hard	trace of cream.
				03	2.3	13.1	15.4	1.88	Dusky pink	Hard	
63-008	28	0.7	6	010	+0.2	19.0	20.0	1.73	Tan	Med. hard	Mottled, chalky.
				08	+0.0	18.2	21.1	1.74	Cream	Med. hard	
				03	0.3	15.8	19.5	1.77	Cream buff	Med. hard	
63-010	28	0.0	6	010	+0.7	18.0	21.0	1.70	Tan grey	Soft	Mottled, chalky.
				08	+0.7	18.1	22.1	1.70	Grey white	Soft	
				03	+0.2	15.9	20.4	1.76	Grey buff	Soft	

Table 35 continued CERAMIC PROPERTIES — NORTHEASTERN ONTARIO CLAYS

Sample	% Water of Plasticity	% Drying Shrinkage	PCE	Cone*	% Firing Shrinkage**	% water Absorption 24-hr. cold	5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
83-575	22	5.6	4	010	+0.3	16.1	17.6	1.81	Salmon	Almost hard	Fair quality.
				06	+0.3	13.9	14.5	1.82	Pink salmon	Almost hard	
				03	4.6	4.6	7.1	20.6	Dark brown	Very hard	
83-574	19	3.9	6	010	+0.7	20.0	23.8	1.65	Light salmon	Almost hard	Fair quality.
				06	+1.3	19.1	24.1	1.63	Tan	Almost hard	
				03	+0.3	15.4	22.6	1.69	Buff brown	Almost hard	
83-604	20	3.5	4	010	+0.3	11.8	13.0	1.93	Salmon	Almost hard	Good quality.
				06	1.1	10.6	12.4	1.97	Dark salmon	Hard	
				03	6.7	0.9	1.2	2.26	Red-brown	Very hard	
83-603	20	6.5	4	010	0.4	15.2	16.2	1.86	Tan-salmon	Almost hard	Good quality.
				06	2.0	10.8	11.9	1.99	Salmon	Very hard	
				03	8.1	0.2	0.4	2.39	Dark brown	Very hard	
83-602	21	4.8	5	010	0.0	14.8	17.1	1.80	Tan	Rather soft	Chalky and slightly warped.
				06	+0.5	14.9	16.9	1.80	Salmon	Mod. hard	
				03	3.7	8.3	10.9	2.00	Dusky red	Almost hard	
83-599	24	7.3	2-3	010	0.6	20.0	20.5	1.70	Pink	Mod. hard	Fair, smooth textured.
				06	4.3	19.4	19.6	1.72	Pink	Hard	
				03	11.1	0.2	0.3	2.28	Red	Very hard	
83-597	24	7.0	4	010	+0.4	13.2	14.2	1.92	Salmon	Almost hard	Good quality.
				06	1.4	10.7	12.0	2.00	Salmon	Hard	
				03	7.2	1.4	2.9	2.37	Dark red	Very hard	
83-596	26	9.1	3	010	0.9	18.5	19.2	1.78	Salmon-pink	Hard	Excellent, smooth textured.
				06	3.3	17.7	18.4	1.80	Salmon-pink	Very hard	
				03	10.0	0.2	0.4	0.42	Red	Very hard	
83-595	24	8.8	3	010	1.1	18.6	20.5	1.74	Salmon-pink	Hard	Good quality.
				06	1.5	16.9	19.5	1.75	Salmon-pink	Very hard	
				03	10.3	1.2	1.9	2.27	Red	Very hard	
83-601	22	7.4	3	010	1.1	21.1	22.5	1.71	Pink	Hard	Fair, slightly mottled.
				06	1.8	20.2	21.5	1.73	Pink	Hard	
				03	7.8	6.9	7.9	2.09	Dark pink	Very hard	
83-600	24	7.8	2-3	010	0.5	19.3	19.7	1.78	Tan-salmon	Almost hard	Good quality.
				06	2.0	17.2	17.7	1.82	Salmon	Hard	
				03	11.2	0.2	0.3	2.48	Red	Very hard	
83-599	24	8.0	2-3	010	0.9	20.2	20.6	1.71	Pink	Hard	Good quality.
				06	0.7	19.8	20.2	1.72	Pink	Very hard	
				03	10.5	0.2	0.2	2.43	Red	Very hard	
83-553	27	4.4	4	010	0.0	25.7	28.2	1.55	Tan	Almost hard	Severe spacking, unattractive.
				06	+0.1	24.8	28.4	1.56	Pink-cream	Almost hard	
				03	9.8	16.3	21.9	1.72	Pink-brown	Very hard	

Table 26 continued CERAMIC PROPERTIES — NORTHEASTERN ONTARIO CLAYS

Fired Characteristics

Sample	% Extent of Warping	% Drying Shrinkage	Pyr. Pt.	Colour*	% Firing Shrinkage**	% water Absorption 24-hr cold	% water Absorption 4-hr boiling	Specific Gravity	Colour	Hardness	Remarks
82-S-54	22	4.3	4	010	+0.4	24.0	26.6	1.59	Tan	Rather soft	Streaky
				06	+0.4	22.9	26.3	1.60	Pink-tan	Almost hard	
				03	3.7	12.5	17.1	1.87	Pink-brown		
82-S-53	21	3.3	4	010	+0.7	20.3	23.3	1.67	Tan	Soft	Brown speckled.
				06	+1.0	19.5	23.4	1.66	Cream-tan	Soft	
				03	+0.2	16.2	21.3	1.72	Yellow-brown	Rather soft	
82-S-52	23	4.7	4	010	0.4	21.3	23.1	1.65	Light tan	Almost hard	Streaked and blotchy.
				06	+0.3	20.0	23.0	1.66	Cream-tan	Almost hard	
				03	4.9	10.4	14.1	1.81	Pink-brown	Hard	
82-S-51	24	6.2	4	010	0.9	21.4	22.9	1.72	Tan	Almost hard	Fair, slight cracking and streaking.
				06	0.9	20.4	22.2	1.71	Pink-cream	Hard	
				03	6.1	9.0	10.2	2.04	Yellow-buff	Very hard	
82-S-50	25	6.3	4	010	2.2	23.4	25.4	1.68	Tan	Very hard	Good quality except for slight cracking.
				06	2.1	20.4	21.5	1.74	Cream-white	Very hard	
				03	14.5	4.0	4.5	2.29	Green-yellow	Very hard	
82-S-49	29	7.1	4	010	3.4	20.4	20.9	1.68	Light tan	Hard	Pink streaked.
				06	3.5	17.1	18.1	1.81	Cream	Very hard	
				03	13.7	0.9	1.0	2.49	Green-yellow	Very hard	
82-S-62	29	7.7	4	010	0.7	18.5	19.3	1.76	Tan	Hard	Good quality.
				06	1.3	17.2	18.2	1.74	Tan	Very hard	
				03	8.5	3.0	3.5	2.38	Red-brown	Very hard	
82-S-62	30	—	4	010	—	22.7	23.8	1.64	Tan	Hard	Abundant yellow grain.
				06	—	20.2	22.7	1.73	Tan	Hard	
				03	—	3.9	5.1	2.39	Red-brown	Very hard	
82-S-61	28	5.9	4	010	0.4	20.9	22.0	1.63	Tan-cream	Almost hard	Excellent.
				06	0.7	19.9	22.7	1.67	Cream-yellow	Hard	
				03	7.1	9.1	12.2	2.02	Yellow	Very hard	
82-S-64	29	6.9	4	010	1.4	22.1	22.6	1.63	Light tan	Almost hard	Slightly cracked and blotchy.
				06	1.0	22.2	24.1	1.68	Cream	Almost hard	
				03	8.5	11.9	13.7	2.00	Yellow-buff	Very hard	
82-S-60	25	6.4	4	010	0.7	21.7	22.5	1.63	Tan	Almost hard	Good except for slight cracking.
				06	1.6	21.4	22.9	1.67	Cream-white	Almost hard	
				03	5.2	13.1	14.8	1.96	Yellow-buff	Very hard	
82-S-63	27	7.1	4	010	0.9	22.9	23.8	1.62	Tan	Almost hard	Excellent appearance.
				06	1.5	21.6	22.2	1.68	Cream-white	Almost hard	
				03	5.6	13.2	14.8	1.93	Yellow-buff	Very hard	
82-S-55	26	5.3	4	010	0.5	22.4	22.9	1.62	Tan	Almost hard	Smooth textured, attractive.
				06	0.5	21.9	24.8	1.63	Cream	Hard	
				03	3.4	18.8	22.4	1.73	Buff	Hard	
82-S-56	22	7.5	4	010	2.0	22.2	22.2	1.68	Tan	Very hard	Excellent appearance except for slight cracking.
				06	2.5	21.5	22.6	1.72	Cream	Very hard	
				03	7.1	12.0	14.0	1.86	Yellow-buff	Very hard	

Table 26 continued CERAMIC PROPERTIES - NORTHEASTERN ONTARIO CLAYS

Fired Characteristics

Sample	% Water of Plasticity	% Drying Shrinkage	Fit	Cone*	% Firing Shrinkage**	% water Absorption Dry end	% water Absorption Soaking	Specific Gravity	Colour	Hardness	Remarks
63-627	20	7.1	4	010	1.8	20.3	21.0	1.67	Tan	Very hard	Excellent appearance.
				06	2.7	19.2	19.6	1.71	Cream	Very hard	
				03	6.5	13.4	14.2	1.93	Light yellow	Very hard	
63-634	35	7.9	3-4	010	1.6	23.2	24.4	1.68	Light salmon	Very hard	Streaked with yellow wash.
				06	2.7	21.5	22.9	1.73	Light salmon	Very hard	
				03	2.4	4.51	5.7	2.35	Pink red	Very hard	
63-644	32	8.9	4	010	2.4	22.4	22.2	1.68	Cream tan	Hard	Fair quality.
				06	4.9	18.6	19.7	1.80	Cream	Very hard	
				03	12.3	0.8	2.1	2.55	Green yellow	Very hard	
63-647	24	8.1	3	010	1.7	16.9	20.5	1.77	Salmon	Hard	Good quality.
				06	3.5	11.9	13.4	1.86	Dark salmon	Very hard	
				03	14.2	0.4	0.4	12.30	Dark red	Very hard	
63-649	20	5.1	4	010	0.5	20.2	21.2	1.72	Tan	Almost hard	A few lime pops.
				06	0.2	17.8	20.0	1.73	Cream	Hard	
				03	1.1	10.4	15.9	1.91	Yellow buff	Very hard	
63-659	29	3.5	4-5	010	0.7	18.4	19.4	1.73	Tan	Almost hard	Lime pops extensive.
				06	0.1	15.9	19.2	1.78	Cream	Hard	
				03	8.8	2.9	7.2	2.14	Green yellow	Very hard	
63-669	28	3.5	4	010	0.0	22.9	24.9	1.81	Light tan	Mod. hard	Lime pops extensive.
				06	0.4	22.2	24.5	1.83	Cream	Almost hard	
				03	4.6	8.7	11.7	2.09	Yellow buff	Very hard	
63-927	25	3.5	4-5	010	0.5	20.6	22.4	1.68	Light tan	Almost hard	A few lime pops.
				06	1.1	16.7	22.2	1.80	Cream buff	Almost hard	
				03	3.9	17.1	21.3	1.79	Yellow buff	Hard	

*Equivalent temperatures measured by optical pyrometer: cone 010 (1600°F), cone 06 (1643°F), cone 03 (1886°F).
**A plus (+) sign indicates expansion.

The sections sampled and described on the following pages are further detailed in the analytical Tables 23, 24 and 25.

PARRY SOUND (41)

A thin deposit of red clay is exposed near the top of a gravel pit just north of the dam 30 m (100 feet) east of the Highway 69 by-pass at Parry Sound. The clay is overlain by 0.6-1.8 m (2-6 feet) of yellow stratified sand and fine gravel. Stratification in the granular materials below the clay appears to be truncated against the clay bed, while that above is conformable. One sample was taken as follows.

Sample 62-594: An undulating bed 0.8 m (2½ feet) thick consists of pink-weathering, reddish brown clay, with cream-coloured joint planes. The clay is finely stratified, blocky, and makes sharp contact with the coarse yellow sands both above and below. A few pebbles of rotten gneiss are imbedded in it.

SHEBESHEKONG RIVER (42)

Twelve small bulk samples of brown clay taken at various locations on the Shebeshekong River some 24 km (15 miles) northwest of Parry Sound were submitted for testing by Mrs. V.A. Richter of Downsview. They were said to have been taken from lots 22 to 28 in concession IX of Carling Township. The samples were combined into three samples for testing as follows.

Sample 63-621: Composite of samples 1,2,3,4.
- Sample 1: mottled red-brown and grey-buff, silty, minor roots.
- Sample 2: grey-brown, smooth to silty, sticky, (sand sample not included).
- Sample 3: red-brown, smooth, easy workability, flabby.
- Sample 4: mottled red-brown and grey-buff, smooth.

Sample 63-622: Composite of samples 5,6,7, 8,9,11,12.
- Sample 5: yellow-brown, sandy clay.
- Sample 6: mottled red-brown and grey-buff, silty, gritty, roots common.
- Sample 7: mottled red-brown and grey-buff, smooth.
- Sample 8: grey-brown, gritty, sticky.
- Sample 9: mottled yellow-brown and grey-buff, gritty.
- Sample 11: red-brown slightly mottled with grey, silty.
- Sample 12: grey-brown, sandy clay.

Sample 63-623: Sample 10
- Sample 10: grey with slight rusty mottling, silty to sandy, minor roots

POWASSAN (43)

An interesting clay section containing a unit of folded and truncated varves is exposed in a roadcut in lot 27, concession VIII, South Himsworth Township, west of Powassan. The section is illustrated in Figure 24. A generally heavy sand cover characterizes the rolling terrain in this area.

Sample 62-614: A 3.2 m (10½ feet) sample consists of brown clay, coarsely varved at the base becoming progressively finer towards the top, and comprising about equal proportions of smooth brown clay and olive-grey silt. Varves in the top 1 m (3 feet) of the section are tightly folded and truncated against horizontal varves below and stratified yellow sand above. Occasional pebbles of Precambrian rock are found throughout.

The disturbed clay zone may have resulted from a local re-advance of the ice following deposition of the varved sequence.

STURGEON FALLS (44)

Varved clay is exposed in a creek bank several hundred feet north of Highway 17, 0.4 km (¼ mile) east of the Veuve River Road and 10 km (6 miles) west of Sturgeon Falls. The section is illustrated in Figure 25. Two samples were taken as follows.

Sample 62-611: The top 2 m (8 feet) of the bank consists of uniformly varved olive-grey clay and silt with no stones. Varve thickness decreases progressively, and the ratio of silt to clay increases considerably, towards the top.

Sample 62-610: The lower 2 m (7 feet) consists

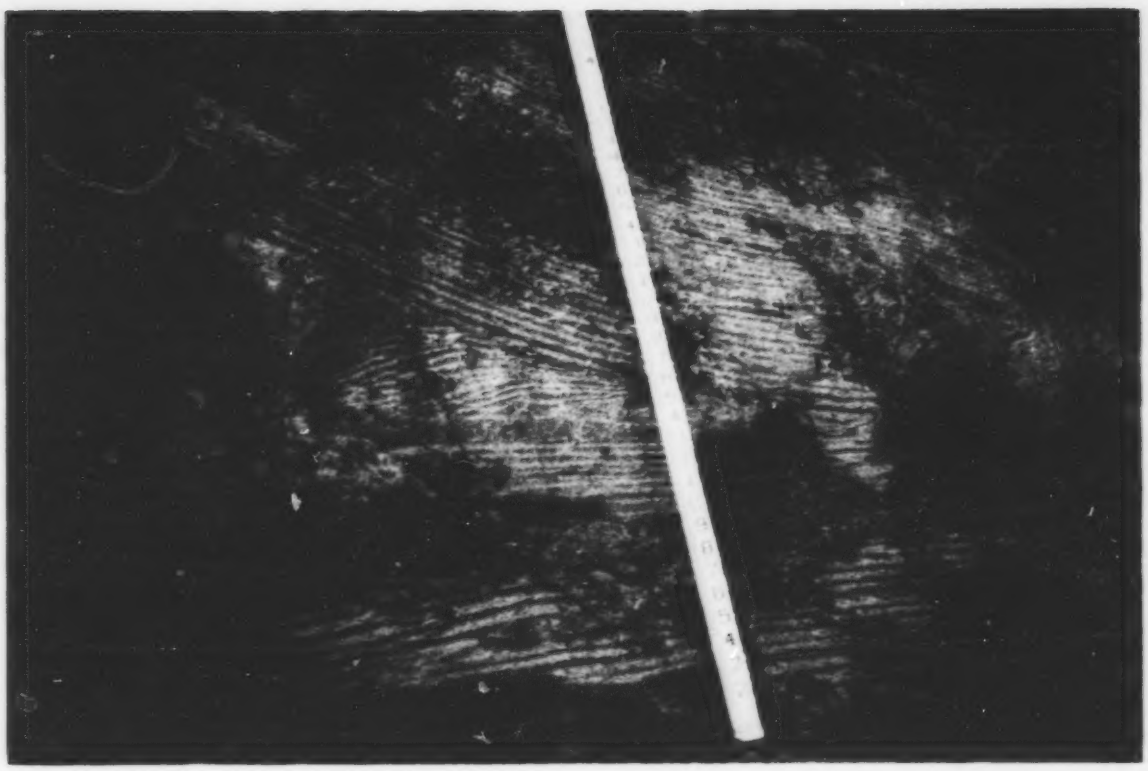


Photo 6 – Distorted varved clay west of Powassan.

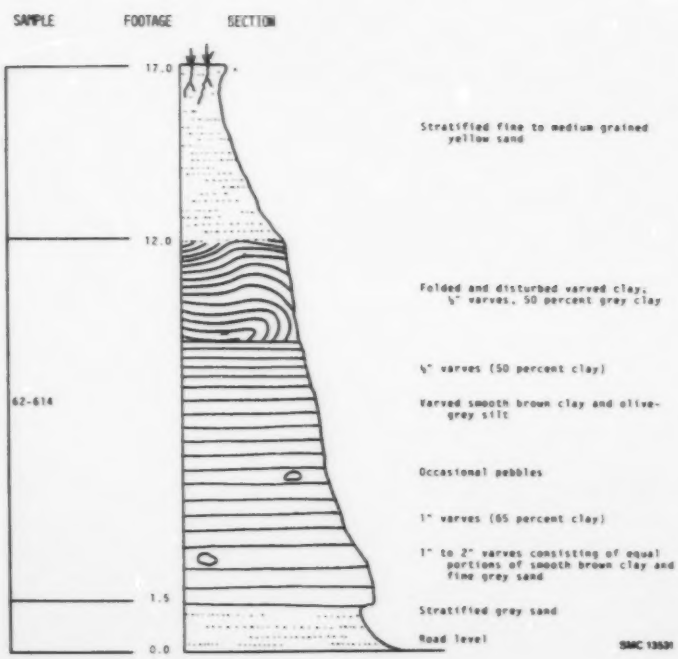


Figure 24 – Varved clay near Powassan.

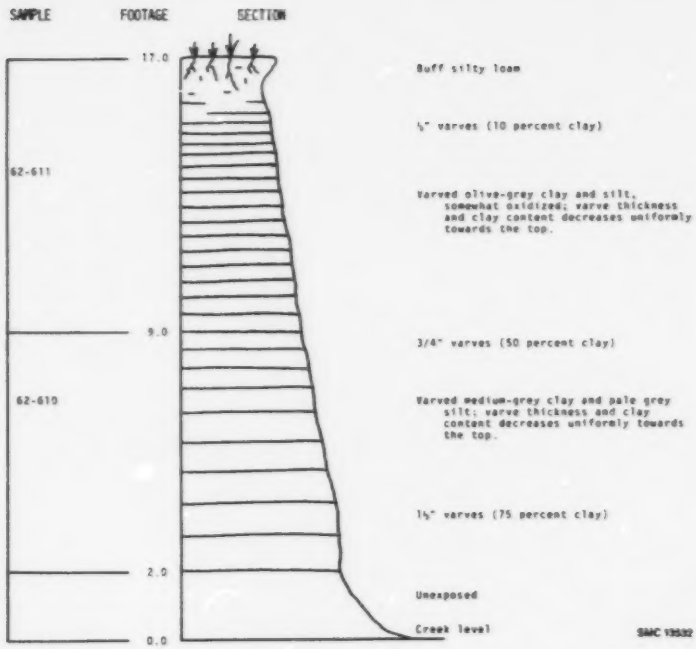


Figure 25 – Varved clay near Sturgeon Falls.

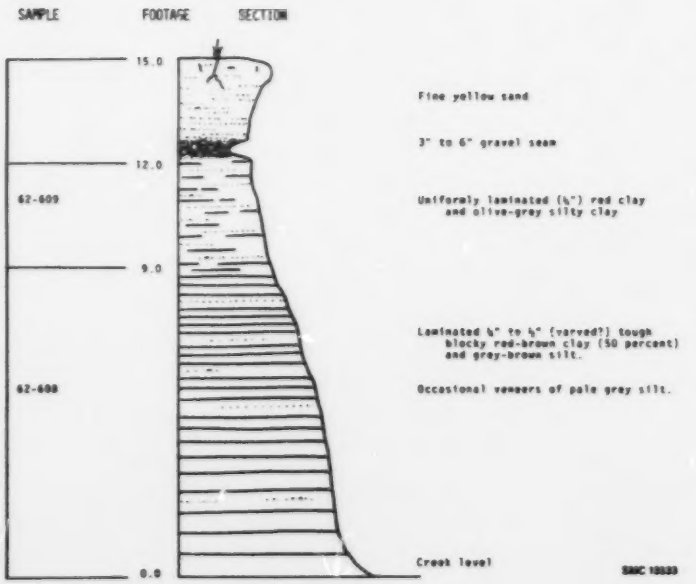


Figure 26 – Clay section at Whitefish.

of coarsely varved medium grey clay and pale grey silt; clay predominates at the base but decreases progressively to the top.

RIVER VALLEY (45)

A small bulk sample of clay was submitted for testing by Mr. Herb Roberts of River Valley. The sample is believed to have come from the River Valley area.

Sample 65-661: A small bulk sample of sandy-textured grey calcareous cl

CREIGHTON (46)

A small bulk sample was submitted for testing by Dr. K. D. Card, geologist. The sample was said to be from a small pit 3 km (2 miles) north of Highway 17 in lot 7, concession V, Graham Township.

Sample 65-660: A small bulk sample of sandy textured brown calcareous clay.

WHITEFISH (47)

A 4 m (12 feet) section of laminated clay is exposed in a creek bank on the south side of Highway 17 in the southwest corner of Graham Township 0.8 km (½ mile) east of Whitefish. The section is illustrated in Figure 26. Two samples were taken as follows.

Sample 62-609: The top 1 m (3 feet) of uniformly laminated (varved?) red clay and olive-grey silt. The clay sample is stoneless, but it underlies a thin gravel seam and 1 m (3 feet) of yellow sand.

Sample 62-608: The bottom 3 m (9 feet) of the bank consists of thinly laminated (varved?) brown-red clay and grey-brown silt in equal proportions. The material is rather tough, blocky weathering, and contains only occasional pebbles.

WEBBWOOD (48)

A thick section of varved clay is exposed in Hallam Township on the south bank of Birch Creek, 180 m (200 yards) south of Highway 17 and 1.6 km (1 mile) west of Webbwood. The section is illustrated in Figure 27. Three samples were taken as follows.

Sample 62-607: The upper 3 m (10 feet) consists of stratified olive-grey silt and fine sand resting on a uniform bed of grey-brown silty clay 0.8 m (2½ feet) thick.

Sample 62-606: The middle 3.3 m (11 feet) section contains a zone of stratified yellow sand, 7.6-45.7 cm (3-18 inches) thick, located between coarsely varved grey clay. The sand seam was not included in the sample.

Sample 62-605: The lower 2.7 m (9 feet) exposed section of the bank consists of very coarsely varved dark grey clay and pale grey silt. The silt layers are faintly stratified, and are the predominant members of the varve couplets.

SANDFIELD (49)

A thin section of clay was sampled in a roadside drainage ditch along Highway 542, 4 km (2½ miles) south of Sandfield. The clay occupies a broad shallow depression in lot 6, concession I, Sandfield Township, Manitoulin Island. The section is illustrated in Figure 28.

Sample 62-575: A 1 m (3½ feet) section of stratified brown clay and grey silt, grading upwards into poorly stratified fine yellow sand and silt.

TEHKUMMAH (50)

A thin section of stratified silt is exposed in the bank of Black Creek on lot 16, concession IV, Tehkummah Township, about 3 km (2 miles) southwest of Tehkummah on Manitoulin Island. The section is illustrated in Figure 28.

Sample 62-574: A section 1 m (3½ feet) thick consists of stratified fine yellow sand, grading upwards through pale brown,

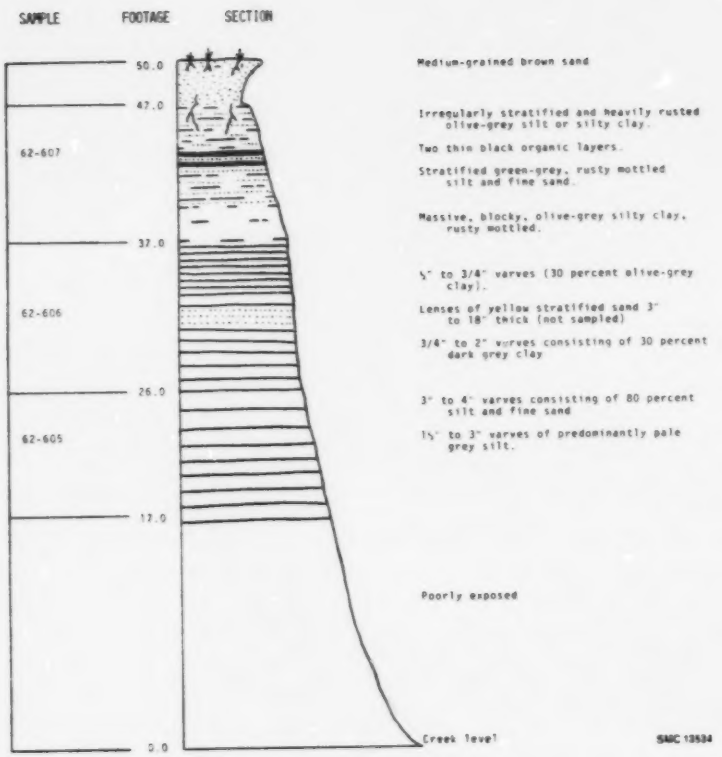
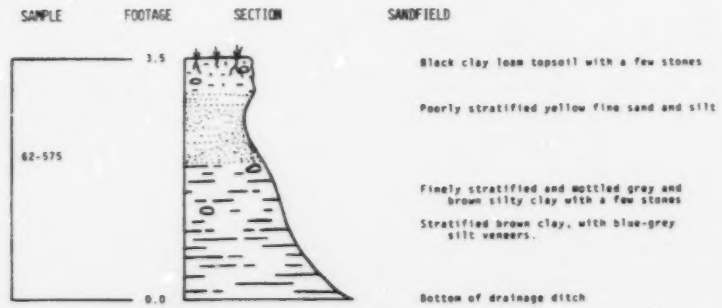

SAMPLE
FOOTAGE
SECTION
50.0
47.0
62-607
37.0
62-606
26.0
62-605
17.0
0.0
Medium-grained brown sand
Irregularly stratified and heavily rusted olive-grey silt or silty clay.
Two thin black organic layers.
Stratified green-grey, rusty mottled silt and fine sand.
Massive, blocky, olive-grey silty clay, rusty mottled.
¼" to 3/4" varves (30 percent olive-grey clay).
Lenses of yellow stratified sand 3" to 18" thick (not sampled)
3/4" to 2" varves consisting of 30 percent dark grey clay
3" to 4" varves consisting of 80 percent silt and fine sand
1½" to 3" varves of predominantly pale grey silt.
Poorly exposed
Creek level
SMC 13534

Figure 27 – Varved clay at Webbwood.



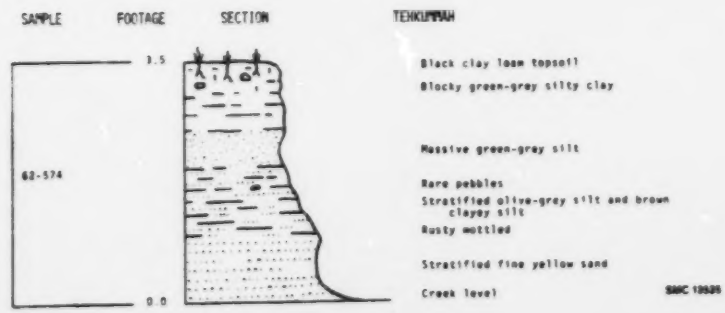


Figure 28 – Clay sections at Sandfield and Tehkummah.

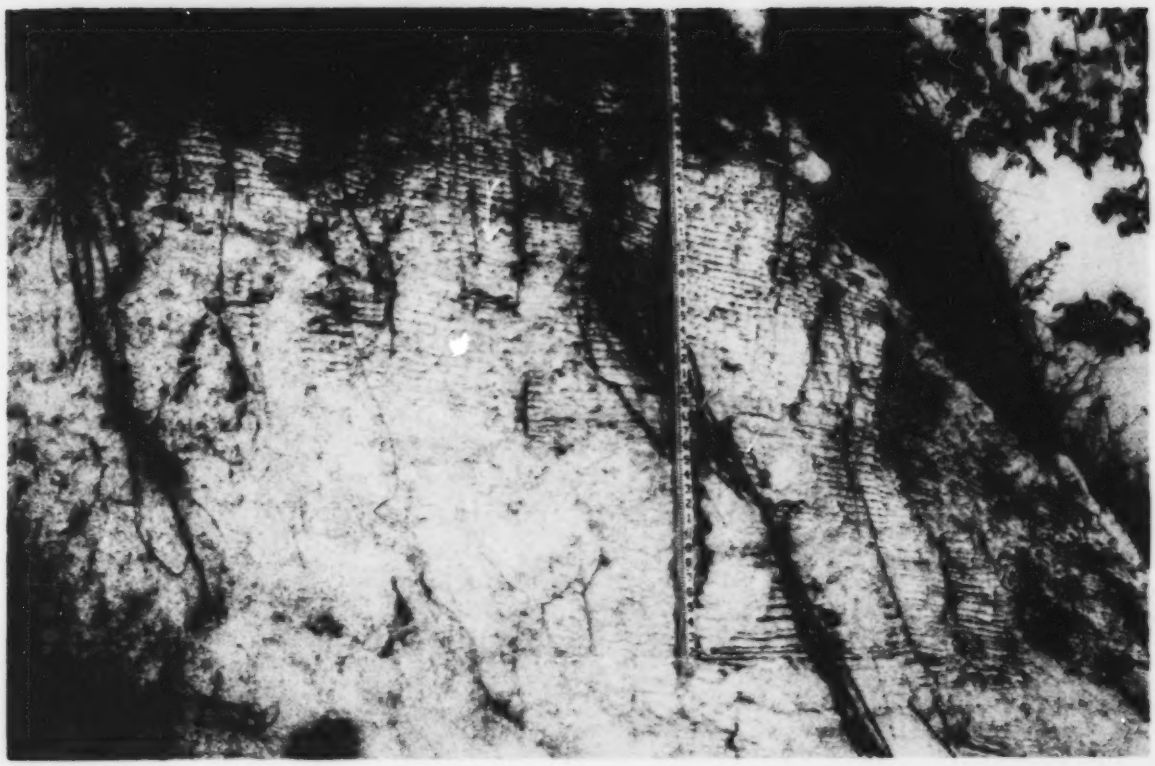


Photo 7 – Clay section in the bank of Livingstone Creek, east of Thessalon.

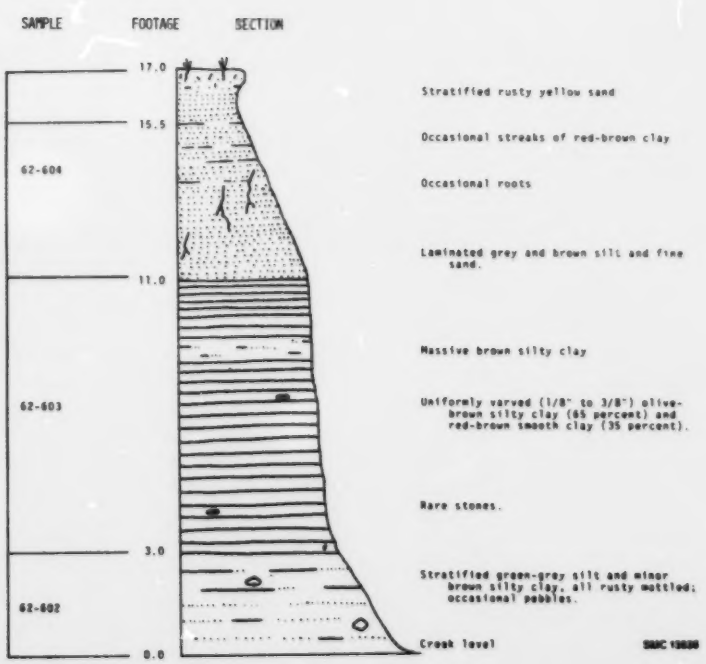


Figure 29 – Clay section near Thessalon.

rusty mottled, clayey silt into green-grey silty clay, topped by black clay loam.

THESSALON (51)

A 5 m (17 feet) clay section topped by several feet of rusty yellow sand is exposed in the bank of Livingstone Creek on the south side of Highway 17, some 13 km (8 miles) east of Thessalon. The section is illustrated in Figure 29. Three samples were taken as follows.

Sample 62-604: The top 1.4 m (4½ feet) section consists of uniformly laminated olive-grey or brown silt and fine sand containing occasional streaks of red-brown clay.

Sample 62-603: A middle 2 m (8 feet) section is uniformly varved olive-brown silty clay and smooth red-brown clay in the proportion of two to one. Occasional stones are present.

Sample 62-602: The bottom 1 m (3 fee) of the bank is green-grey silt stratified with veneers of brown silty clay, rusty mottled and with occasional pebbles.

ST. JOSEPH ISLAND (52)

A thin layer of red plastic clay was sampled in a drainage ditch and creek bank in lot 5, concession A, St. Joseph Township, in the Green Point area of northwest St. Joseph Island. The clay appears to occupy depressions between low ridges of till and bedrock.

Sample 62-598: A 0.6 m (2 feet) sample of plastic red-brown stoneless clay, stratified at intervals of 1.2-2.5 cm (½-1 inch) with veneers of brown silty clay.

TARBUTT (53)

Highway 17 traverses a broad flat clay plain for some distance in the area north of St. Joseph Channel. The clay section was sampled in a creek bank and drainage cut on the north side of the highway in the southwest corner of Tarbutt Township. The section is illustrated in Figure 30. Four samples were taken as follows.

Sample 62-597: The top 0.8 m (2½ feet) of the bank consists of stratified red-brown clay and fine brown sand, loamy at the top.

Sample 62-596: The middle portion of the bank consists of 1.5 m (4½ feet) of loamy-textured red-brown clay mottled with green-grey. The section is faintly laminated.

Sample 62-595: The bottom 1.5 m (4½ feet) is sticky red-brown clay, irregularly stratified with veneers of pale grey silt, and mottled with green-grey patches associated with root channels.

Sample 62-597A: A composite of the previous three samples.

In 1962 local red clay was being used in making art pottery in Johnstone's Pottery studio, 0.4 km (¼ mile) west of this location. His products were being fired in an electric furnace to 1038°C (1900°F). Mr. Johnstone told the writer that the following clay section was intersected in the course of digging his well (from top to bottom):

1 m (3 feet) of sand.
3-5 m (10-15 feet) of red clay.
3-5 m (10-15 feet) of blue clay.
Quicksand encountered at 9 m (30 feet).

BAR RIVER (54)

A clay section similar to the one at Tarbutt, about 11 km (7 miles) to the south, was sampled in a roadcut at the intersection of Calabogie Road and Highway 17, 2 km (1 mile) or so south of Bar River. The section is illustrated in Figure 31. Three samples were taken as follows.

Sample 62-601: The top 2 m (8 feet) of the bank consists of laminated red plastic clay with veneers of grey silt, loamy at the top.

Sample 62-600: The middle 1.5 m (5 feet) section consists of olive-brown silty clay, massive to finely laminated.

Sample 62-599: The bottom 1.5 m (5 feet) is stratified olive-brown and red clay in which the red clay layers are dominant (averaging 1.2 cm; ½ inch in thickness to 0.3 cm; 1/8 inch for the brown clay). Light-coloured spheroidal concretions are occasionally present throughout the bank.

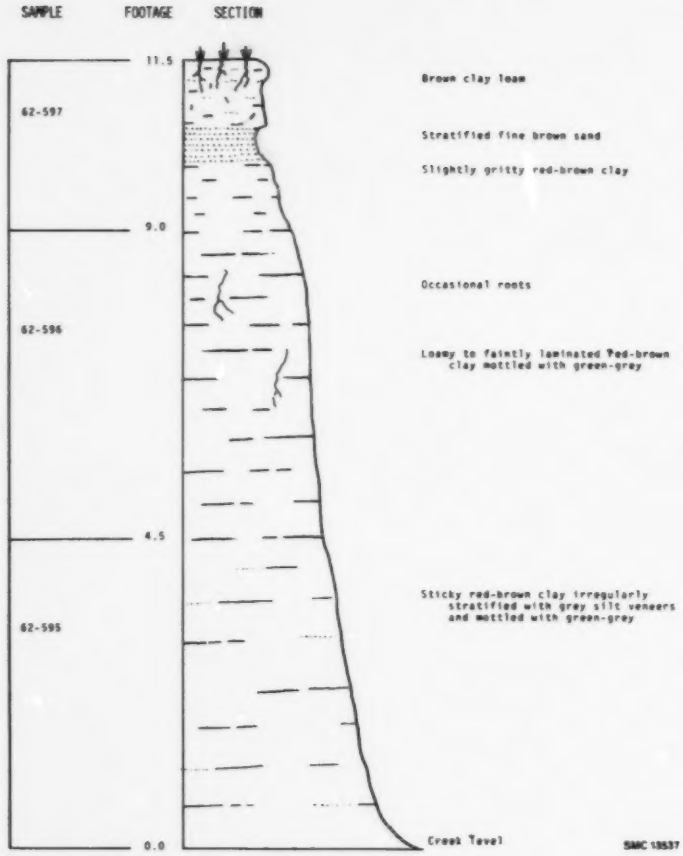


Figure 30 – Tarbutt clay.

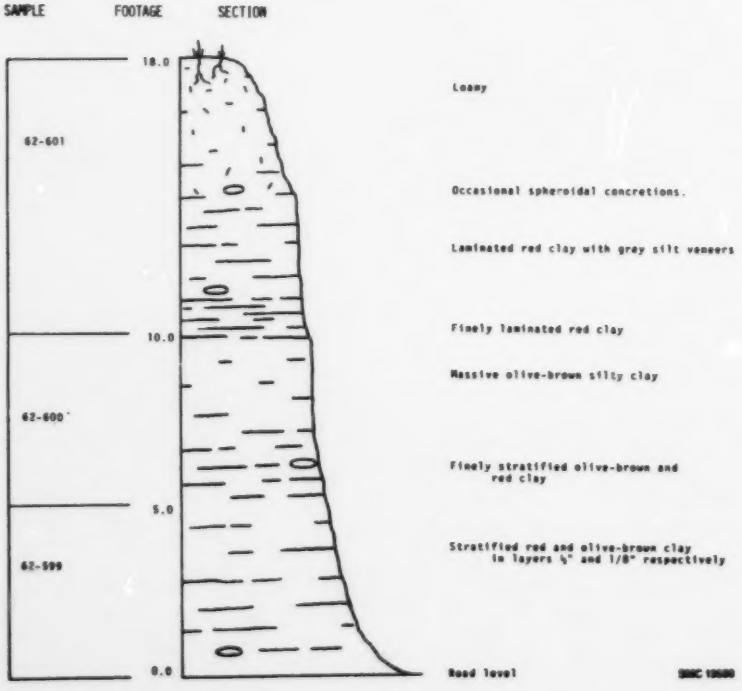


Figure 31 – Bar River clay.

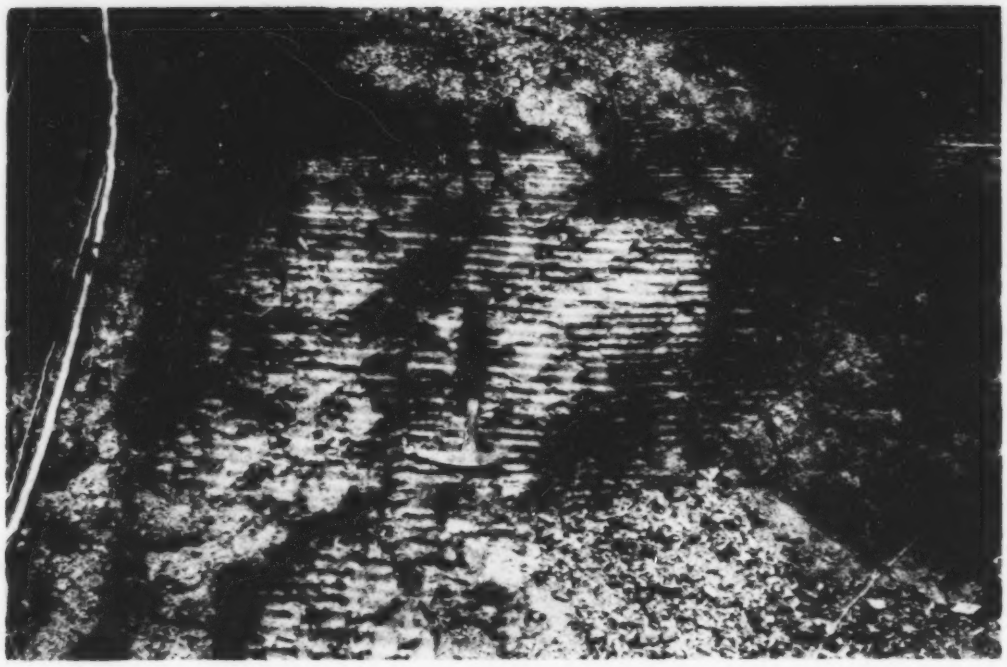


Photo 8 – Varved clay on the north shore of Nighthawk Lake.

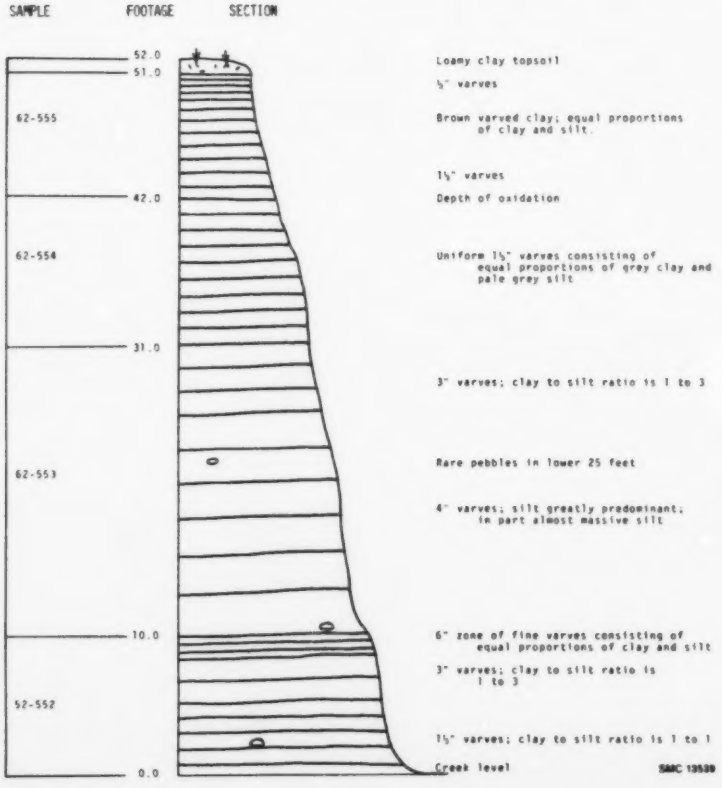

SAMPLE
FOOTAGE
SECTION
52.0
51.0
62-555
42.0
62-554
31.0
62-553
10.0
52-552
0.0
Loamy clay topsoil
½" varves
Brown varved clay; equal proportions of clay and silt.
1½" varves
Depth of oxidation
Uniform 1½" varves consisting of equal proportions of grey clay and pale grey silt
3" varves; clay to silt ratio is 1 to 3
Rare pebbles in lower 25 feet
4" varves; silt greatly predominant; in part almost massive silt
6" zone of fine varves consisting of equal proportions of clay and silt
3" varves; clay to silt ratio is 1 to 3
1½" varves; clay to silt ratio is 1 to 1
Creek level
SAIC 13530

Figure 32 – Varved clay near Earlton.

EARLTON (55)

A thick section of varved clay is exposed in the bank of Evanturel Creek, north of McCool and 6 km (4 miles) southwest of Earlton. The section is probably typical of the Northern Ontario 'Clay Belt', the site of the Barlow-Ojibway glacial lakes. The section is illustrated in Figure 32. Five samples were taken as follows.

Sample 62-555: The top 2.7 m (9 feet) section of brown oxidized varved clay, the varves decreasing from 3.8 cm (1½ inches) in thickness at the base to 1.2 cm (½ inch) at the top, with a corresponding decrease in the ratio of clay to silt from 1 to 1 at the base to 1 to 2 at the top.

Sample 62-554: A 3.3 m (11 feet) section of unoxidized grey varved clay, uniformly varved at 3.8 cm (1½ inch) thickness and with equal proportions of clay and silt.

Sample 62-553: A 6 m (21 feet) section of coarsely varved grey silt, consisting predominantly of 10 cm (4 inch) silt layers separated by 0.6 cm (¼ inch) veneers of silty clay, giving way at the top to a 2 m (6 feet) zone of 7.5 cm (3 inch) varves of clay and silt in the ratio of 1 to 3. Rare pebbles.

Sample 62-552: The bottom 3.3 m (11 feet) is predominantly varved in thicknesses of 3.8 cm (1½ inches), in which clay and silt are in equal amounts. However, the upper 1 m (4 feet) of the unit consists of 7.6 cm (3 inch) varves having a clay to silt ratio of 1 to 3. Rare pebbles.

The lower 8 m (25 feet) of the bank contains occasional pebbles consisting of banded red and black iron formation, green and black mafic rocks, granitic varieties, and Paleozoic limestone in about equal numbers.

Sample 62-555A: A composite of the previous four samples.

MATHESON (56)

A thick section of clay is exposed in a creek bank and drainage ditch 3 km (2 miles) north of Matheson. The section is illustrated in Figure 33. Three samples were taken as follows.

Sample 62-551: The top 1.1 m (3½ feet) of the bank consists of several feet of varved brown clay, topped by 0.4 m (1 foot) of yellow-silt and a thin covering of clay-loam topsoil.

Sample 62-550: Only the upper 2.0 m (6½ feet) of the underlying 6.5 m (21½ feet) to road level is exposed. It consists of massive, blocky, tough brown clay mottled with blue and rusty markings, particularly along root channels; stoneless.

Sample 62-549: A 1 m (3 feet) section exposed in a drainage ditch below road level consists of grey varved clay and silt in which the clay component comprises about 70 percent.

MOOSE LAKE (57)

Varved clay occurs in a terraced exposure on the east shore of Moose Lake. Four samples were taken as follows. A few pebbles on the clay shore must come from the varved clay bank.

Sample 62-543: The upper 1.5 m (5 feet) is a mixed section consisting of successive layers of massive brown clay, varved clay, and massive yellow silt.

Sample 62-542: A middle 3 m (9 feet) section is separated from the previous unit by an unexposed interval of 1.5 m (5 feet). The middle unit consists of grey varved clay in which the proportion of clay to silt averages 3 to 1. Varve thickness is about 2.5 cm (1 inch) at both the bottom and top of the section, but progressively less towards the centre to a minimum of 0.6 cm (¼ inch).

Sample 62-541: The bottom 2 m (7 feet) to lake level is coarsely varved greasy grey clay in the ratio of 40 percent clay, 60 percent silt. The unit is stoneless and rootless, but contains occasional concentric rusty concretions.

Sample 62-543A: A composite of the previous three samples.

NIGHTHAWK LAKE (58)

Varved clay is exposed in many places on the shore of Nighthawk Lake. A section sampled

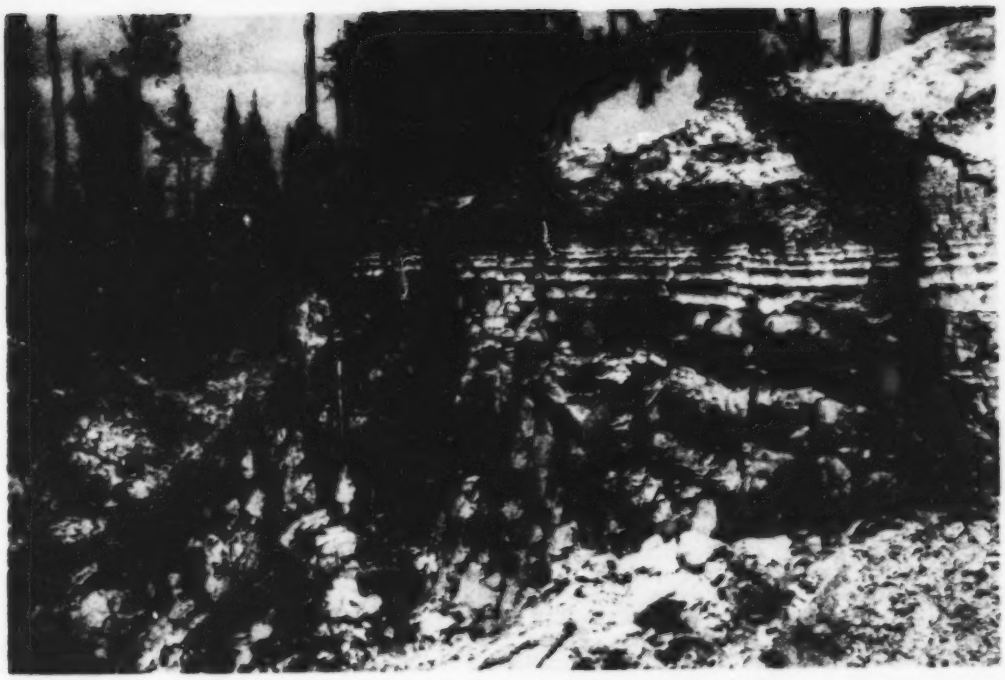


Photo 9 – Clay section east of mileage 34 on the "Trans-Limit" Abitibi Road.

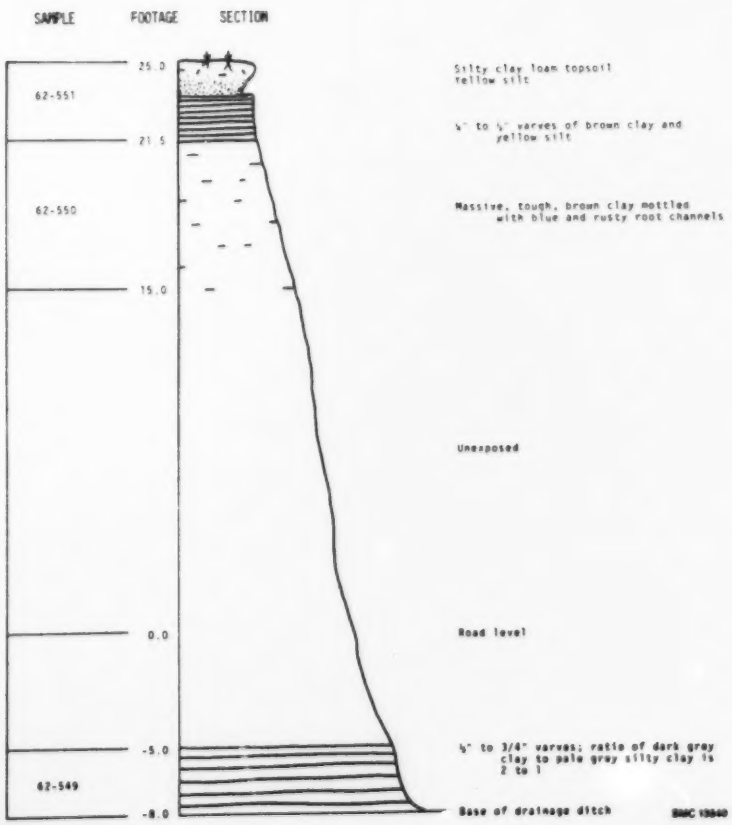


Figure 33 – Clay section at Matheson.

on the peninsula that extends into the lake from the north end is illustrated in Figure 34. The section is located 180 m (200 yards) southeast of the Peninsula Gold Mines shaft. Precambrian bedrock is exposed in the lower part of the bank, and the following sample represents only the top 3 m (10 feet) of the bank.

Sample 62-544: A 3 m (10 feet) section of varved sticky brown clay and olive-grey silt, consisting of varve thicknesses of 3.8 cm (1½ inches) at the base (comprising 50 percent each of clay and silt), decreasing to 1.2 cm (½ inch) or less in the middle section (80 percent clay), and increasing again to about 1.9 cm (3/4 inch) at the top (50 percent clay).

IROQUOIS FALLS (59)

Varved clay is widespread in the Abitibi area. Exposures of 5-6 m (15-20 feet) in thickness are common along the Abitibi River, and 15 m (50 feet) or more may be present in places. A section sampled 90 m (100 yards) south of the bridge, 0.8 km (½ mile) north of Iroquois Falls, appears to be a re-worked clay derived from glacial clays and redeposited in the Abitibi River valley. Two samples were taken from a 5 m (18 feet) bank in the bottom of the valley as follows.

Sample 62-546: Smooth brown clay and minor silt, stratified at 5-10 cm (2-4 inches), comprises the upper 1 m (4 feet).

Sample 62-545: 1.5 m (5 feet) immediately above the river level is unexposed, but the next 3 m (9 feet) consists of poorly and irregularly stratified brown clay and grey-buff silt. The clay occurs in beds 15-90 cm (6 inches to 3 feet) thick, and is blocky, massive, smooth, tough and stoneless. Silt occurs in thin, poorly defined layers, often crumpled and lenticular, and comprising not more than 10 percent of the unit.

ABITIBI RIVER (60)

East of Iroquois Falls, the Abitibi River runs through Rickard, Knox, and Kerrs Townships. P.S. Simony (1965) describes the geology of these townships, including descriptions of the clays. During the course of his field work Simony contributed four samples of varved clay for testing, as follows (Simony 1965, p.19-20).

Sample 63-625: A 1 m (3 feet) sample from the northeast quarter of lot 13, concession I, Knox Township.

Sample 63-626: A 0.6 m (2 feet) sample from the northwest quarter of lot 9, concession V, Knox Township.

Sample 63-627: A 1.2 m (4 feet) sample from the southwest corner of lot 3, concession VI, Rickard Township.

Sample 63-654: A 2 m (6 feet) sample from the bank of the river in Kerrs Township.

ABITIBI ROAD (61)

The "Trans-Limit" road of the Abitibi Power and Paper Company gives access to a wide area north and west of Lake Abitibi. Two sections of varved clay exposed in banks along the road were sampled at Mileage 34 (55 km) and Mileage 47 (76 km). The first location is a 2.2 m (7½ feet) section in a drainage ditch on the north side of the road 300 m (1,000 feet) east of the number 34 mileage (55 km) marker. It was sampled as follows.

Sample 62-548: A 2.2 m (7½ feet) section consists of a lower 1.5 m (5 feet) unit of massive sticky olive-clay, overlain by a foot of irregularly stratified clay with silt veneers, topped by 0.5 m (1½ feet) of varved clay. Varve thickness is very coarse (7.5 cm; 3 inch) initially, but diminishes rapidly at the top. Clay greatly predominates over silt throughout the section.

The second location is also a drainage ditch at the roadside, about 210 m (700 feet) east of the number 47 mileage (76 km) marker in the southwest corner of Case Township. The section is illustrated in Figure 35.

Sample 62-547: A 1.5 m (5 feet) section comprises 1 m (3 feet) of thinly varved smooth olive-grey clay and pale brown silty clay, topped by 0.6 m (2 feet) of slightly gritty, tough, massive brown clay, all stoneless.

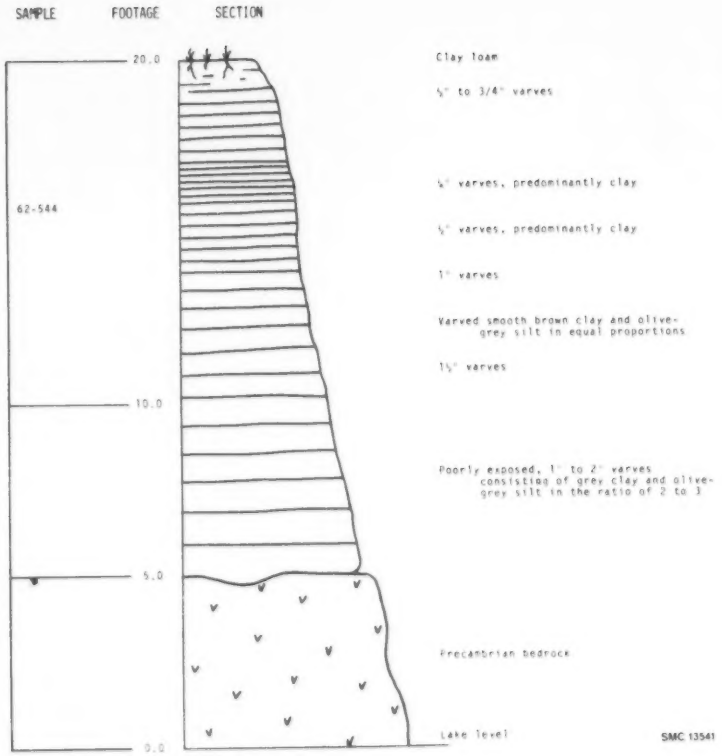


Figure 34 – Varved clay at Nighthawk Lake.

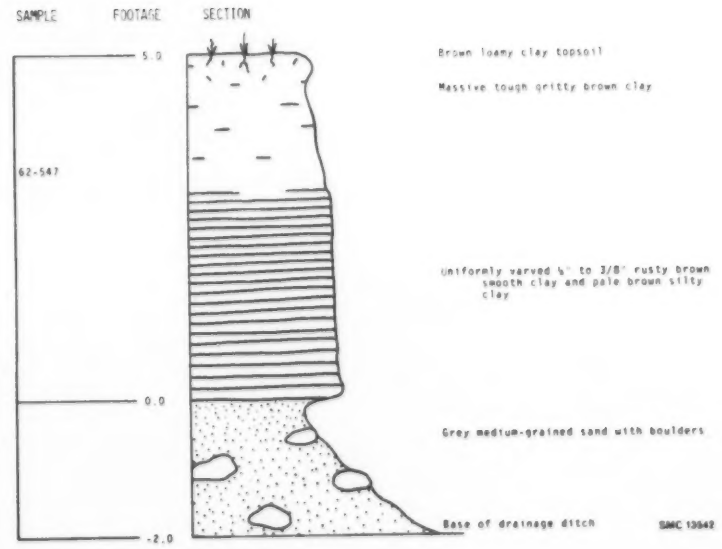


Figure 35 – Abitibi clay.

BUSKEGAU RIVER (62)

Glacial till with a relatively low content of stones is exposed in the upper portion of the west bank of the Buskegau River where it crosses Highway 11 some 16 km (10 miles) west of Cochrane. The stones vary up to boulder-size but are commonly less than 2.5 cm (1 inch). They are predominantly of Precambrian origin; pebbles of rotten dark gneiss are particularly conspicuous, but Paleozoic limestone pebbles may comprise as much as 20 percent. The till becomes stonier with depth, and the lower 5 m (15 feet) of the bank to river level was not sampled. Two samples from the upper 3 m (12 feet) of the bank were taken as follows.

Sample 62-540: The top 1.5 m (5 feet) consists of dense, massive, plastic brown clay with a low content of stones and some rusty mottling along root channels.

Sample 62-539: The underlying 2 m (7 feet) is unoxidized grey plastic clay with a moderate stone content.

KAPUSKASING (63)

A recent clay, reworked from the glacial deposits of the region, has been deposited in the valley of the Kapuskasing River and now forms the banks of the present river in certain areas. One exposure in the west bank was sampled at a point 3 km (2 miles) southwest of Kapuskasing. The lower 2 m (6 feet) to river level was unexposed, and the following sample represents the rest of the 4 m (13 feet) bank.

Sample 62-538: A 2 m (7 feet) section consisting of a lower 1 m (3 feet) unit of massive, tough, blocky, plastic brown clay with minor rusty mottlings and rare pebbles, overlain by 1.2 m (4 feet) of coarsely stratified buff-brown silt in layers 7.5-15 cm (3-6 inches) thick alternating with brown clay in layers 2.5-7.5 cm (1-3 inches) thick. Silt becomes more predominant towards the top before grading into a few inches of clay-loam topsoil.

HEARST (64)

A shallow section of laminated (varved?) clay is exposed in a roadcut on the southern limits of Hearst, 0.4 km (¼ mile) south of the Mattawishkwia River bridge on Highway 583. One sample was taken as follows.

Sample 62-537: A 1 m (3 feet) section of uniformly laminated medium brown sticky clay and pale grey-brown silty clay contains only an occasional stone. Laminations of about 5 cm (2 inches) at the base decrease progressively to 2.5 cm (1 inch) at the top. The clay appears to continue to greater depth but is unexposed.

Clays of Northwestern Ontario

Varved clays are widespread in Northwestern Ontario, as a result of a succession of post-glacial lakes in the Lake Superior basin, and Lake Agassiz in the west. Lake Agassiz occupied the area extending west of Thunder Bay into Manitoba, to a greater or less extent, during a 3,000 year period commencing 12,800 years ago (Prest 1970, p.716-721).

The glacial ice commenced its withdrawal from the Lake Superior basin about the same time as the formation of early Lake Agassiz. A number of lake stages dating from that time to the present have been referred to by the names Keweenaw, Duluth, Minong, Houghton, Nipissing, and finally Superior. None of these lakes extended their shores very far beyond the present shoreline of Lake Superior, except along the valleys of the major rivers where thick sequences of varved clay and silt may be observed for many miles in some cases.

Non-varved stoneless clays were deposited from some of the later stage lakes, and more recent stratified clays have originated by reworking of earlier ones, including tills, and redeposition on recent flood plains.

Analytical data for the clays described on the following pages are given in Tables 26, 27 and 28.

Clays throughout the region are also described by Keele (1924, p.125-133). Those of the Thunder Bay area are further described by Keele (1920, p.105-108).

CLAYS OF NORTHWESTERN ONTARIO

SAMPLE DESCRIPTIONS FOR TABLES 26, 27 AND 28

62-517: Pic River (65); roadcut on Highway 627, about 2 miles (3 km) south of its junction with Highway 17; upper 8 feet (2 m) of varved clay.
62-516: Pic River (65); location as above; lower 6 feet (2 m) of coarsely varved clay.
63-650: Pic River (65); elsewhere along the Pic River; 15 feet (5 m) of varved clay.
63-651: Pic River (65); elsewhere along the Pic River; 10 feet (3 m) of varved clay.
63-652: Pic River (65); elsewhere along the Pic River; 15 feet (5 m) of varved clay.
63-653: Pic River (65); elsewhere along the Pic River; 5 feet (1.5 m) of varved clay.
62-536: Nipigon (66); Helen Lake, 4 miles (6 km) north of junction of Highways 17 and 11; top 10 feet (3 m) of varved clay.
62-535: Nipigon (66); location as above; lower 15 feet (5 m) of coarsely varved silt and clay.
62-536A: Nipigon (66); composite of previous two samples.
62-531: Dog Lake (67); pit bank on Dog Lake Road a mile (1.6 km) east of the Silver Falls powerhouse; upper 7½ feet (2 m) of red clay.
62-530: Dog Lake (67); location as above; lower 5½ feet (1.7 m) of stratified yellow and grey silt.
63-532: Finmark (68); roadbank 100 yards (90 m) north of Finmark station; small bulk sample of red clay.
63-533: Finmark (68); roadbank ½ mile (0.8 km) south of Finmark; 8 feet (2 m) of red clay.
62-534: Finmark (68); roadbank ¼ mile (0.4 km) east of the Highways 17A and 17 junction; 20 feet (6 m) of red clay.
62-529: Pine Bay (69); Pine River bank a mile (1.6 km) east of Highway 61; top 4 feet (1 m) of red-brown clay.
62-528: Pine Bay (69); location as above; middle 4 feet (1 m) of brown clay.
62-527: Pine Bay (69); location as above; lower 3 feet (1 m) of grey silt.
62-529A: Pine Bay (69); location as above; composite of previous three samples.
62-525: Pine Bay (69); Memory Road, 1½ miles (2 km) east of Highway 61; 2 feet (0.6 m) of red plastic clay.
62-526: Pine Bay (69); ¼ mile (0.4 km) west of previous location; 2 feet (0.6 m) of loamy brown clay.
62-519: Wabigoon Lake (70); Contact Bay shore, 16 miles (26 km) south of Dryden; upper 3 feet (1 m) of brown varved clay.
62-518: Wabigoon Lake (70); location as above; lower 3 feet (1 m) of red varved clay.
62-520: Kenora (71); roadbank near Laclu, 9 miles(14 km) west of Kenora; 3 feet (1 m) of loamy brown clay.
62-619: Kenora (71); northeast outskirts of Kenora; 3 feet (1 m) of varved clay.
62-620: Kenora (71); shore of Lake-of-the-Woods at Norman, several miles west of Kenora; grey silty clay.
63-624: Redditt (72); 20 miles (32 km) north of Kenora; 3 feet (1 m) of silty grey clay.
62-521: Rainy River (73); bank of Rainy River 2 miles (3 km) west of town; 5.3 feet (2 m) of stratified silty clay.
62-522: Emo (74); roadbank on Highway 602 on the south of Emo; 3 feet (1 m) of stratified silt and clay.
62-524: Fort Frances (75); pit bank on the south side of Highway 11 at the west end of town; top 5 feet (1.5 m) of grey till.
62-523: Fort Frances (75); location as above; underlying 5 feet (1.5 m) of stonier till.
66-662: Glenorchy (76); Highway 11, 50 miles (80 km) east of Fort Frances; small bulk sample of buff clay.
63-648: Red Lake (77); small bulk sample of smooth brown clay.
63-649: Red Lake (77); small bulk sample of smooth brown clay.

TABLE 26 CHEMICAL ANALYSES – NORTHWESTERN ONTARIO CLAYS.

Sample No.	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	TiO_2 %	CO_2 %	H_2O^+ %	H_2O^- %	SO_3 %	MnO %	Total %	Loss on Ignition %	Soluble Salts %
62-517	–	–	2.48	18.90	–	–	–	–	–	–	–	–	–	–	13.29	0.85
62-516	–	–	2.90	19.10	–	–	–	–	–	–	–	–	–	–	21.58	1.76
63-650	42.3	9.67	3.88	17.60	5.30	1.42	2.27	0.45	15.75	1.59	1.00	0.36	0.09	101.7	19.19	–
63-651	–	–	3.57	16.60	–	–	–	–	–	–	–	–	–	–	20.02	0.85
63-652	–	–	1.93	15.90	–	–	–	–	–	–	–	–	–	–	19.34	0.74
63-653	–	–	3.93	17.20	–	–	–	–	–	–	–	–	–	–	20.61	0.99
62-536	–	–	3.16	16.20	–	–	–	–	–	–	–	–	–	–	18.48	0.60
62-535	–	–	3.47	16.40	–	–	–	–	–	–	–	–	–	–	19.03	0.95
62-536A	43.1	8.30	3.23	16.90	5.98	1.52	1.79	0.48	15.92	0.95	0.54	Nil	0.06	98.8	18.44	–
62-531	47.3	13.00	7.53	9.20	5.85	1.23	2.41	0.53	6.62	2.59	2.47	Nil	0.09	98.8	12.07	–
62-530	–	–	5.98	9.22	–	–	–	–	–	–	–	–	–	–	10.81	0.80
62-532	–	–	6.59	9.43	–	–	–	–	–	–	–	–	–	–	16.08	0.72
62-533	–	–	7.84	7.33	–	–	–	–	–	–	–	–	–	–	13.13	1.07
62-534	–	–	7.96	7.90	–	–	–	–	–	–	–	–	–	–	14.54	0.64
62-529	–	–	5.31	9.75	–	–	–	–	–	–	–	–	–	–	11.69	0.95
62-528	–	–	5.57	9.58	–	–	–	–	–	–	–	–	–	–	10.19	0.96
62-527	–	–	4.52	8.43	–	–	–	–	–	–	–	–	–	–	7.66	0.70
62-529A	52.4	10.70	5.41	9.70	6.65	1.57	2.22	0.55	7.84	1.52	0.81	0.18	0.08	98.6	9.63	–
62-525	–	–	7.77	2.00	–	–	–	–	–	–	–	–	–	–	7.54	0.79
62-526	–	–	5.27	9.36	–	–	–	–	–	–	–	–	–	–	10.43	1.03
62-519	–	–	6.77	8.53	–	–	–	–	–	–	–	–	–	–	5.77	0.90
62-518	–	–	7.13	8.55	–	–	–	–	–	–	–	–	–	–	11.51	1.24
62-520	–	–	4.56	1.87	–	–	–	–	–	–	–	–	–	–	–	1.14
62-619	–	–	4.46	2.34	–	–	–	–	–	–	–	–	–	–	4.56	1.48
62-620	–	–	4.37	1.92	–	–	–	–	–	–	–	–	–	–	4.72	1.45
63-624	–	–	2.72	3.93	–	–	–	–	–	–	–	–	–	–	3.06	0.64
62-521	–	–	2.30	11.80	–	–	–	–	–	–	–	–	–	–	16.50	0.77
62-522	–	–	2.72	14.20	–	–	–	–	–	–	–	–	–	–	19.90	1.24
62-524	–	–	3.57	12.00	–	–	–	–	–	–	–	–	–	–	18.96	1.28
62-523	–	–	3.44	10.90	–	–	–	–	–	–	–	–	–	–	18.14	0.89
66-662	–	–	5.58	2.51	–	–	–	–	–	–	–	–	–	–	5.52	0.83
63-648	–	–	5.73	4.46	–	–	–	–	–	–	–	–	–	–	10.02	1.13
63-649	–	–	6.33	4.60	–	–	–	–	–	–	–	–	–	–	10.18	0.87

TABLE 27 MINERAL ANALYSES — NORTHWESTERN ONTARIO CLAYS.

Sample No.	Non-clay minerals: Quartz	Calcite	Dolomite	Soda-lime feldspar	Potash feldspar	Amphibole	Clay minerals: Illite	Chlorite	Expanding mineral
	%	%	%	%	%	%			
62-517	18	17	15	2	1	<1	B	B	C (MI)
62-516	20	21	15	5	1	<1	B	B	C (IM)
63-650	21	19	13	3	1	<1	B	A	—
63-651	19	19	16	4	1	<1	B	B	C
63-652	26	13	18	4	<0.5	1-5	B	B	—
63-653	17	21	13	4	<0.5	1-5	B	A	—
62-536	21	15	14	7	1	<1	B	A	ND
62-535	22	17	14	5	<1	<1	B	B	ND
62-531	19	7	4	4	1	<1	A	B	C
62-530	16	6	5	7	1	<1	A	A	C
62-532	11	12	3	3	1	<1	A	B	C
62-533	13	7	3	3	1	<1	B	C	A (M)
62-534	13	9	4	3	<1	<1	A	B	ND
52-529	22	7	7	5	1	<1	B	B	C
62-528	30	7	7	8	<1	<1	B	B	B (MI)
62-527	27	5	8	10	1	<1	B	A	ND
62-525	18	ND	<1	5	2	ND	B	C	A (IM)
62-526	24	4	7	5	1	ND	A	B	C (M)
62-519	13	7	4	7	1	<1	A	B	C (I)
62-518	13	9	4	5	1	<1	A	B	C (I)
62-520	29	1	<1	7	2	ND	B	B (?)	A (M)
62-619	31	ND	<1	13	2	1-5	B	C	B (IM)
62-620	34	ND	<1	8	1	<1	C	C	A (I)
63-624	51	0.5	3	11	2	1-5	A	C	—
62-521	22	8	20	5	2	<1	C	C	A (M)
62-522	16	11	23	9	4	<1	C	C (?)	B (M)
62-524	24	9	12	4	1	ND	C	C	A (M)
62-523	16	9	13	5	1	ND	C	C	A (M)
66-662	31	ND	ND	5	3	1-5	D	C	A (M)
63-648	28	5	3	5	1	1-5	A	B	B (MI)
63-649	17	3	2	6	1	<1	B	B	A (MI)

(M = Montmorillonite; I = Interlayered)
(A = Abundant; B = Moderate; C = Minor; D = Trace; ND = Not detected).

TABLE 28 CERAMIC PROPERTIES - NORTHWESTERN ONTARIO CLAYS.

Sample	% Water of Plasticity	% Drying Shrinkage	PCE	Fired characteristics: Cone*	% Firing Shrinkage**	% water Absorption: 24-hr. cold	% water Absorption: 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-528	24	5.1	4	010	+0.4	18.8	21.9	1.69	Mauve	Rather soft	Overfired and deformed at cone 03.
				06	+0.2	19.2	21.7	1.69	Light mauve	Rather soft	
				03	3.0	8.7	10.1	2.06	Mauve-brown	Hard	
62-527	23	3.8	4	010	+0.7	21.7	24.7	1.62	Mauve	Soft	Slight warping.
				06	+0.9	19.8	24.2	1.65	Light mauve	Soft	
				03	+0.3	19.3	23.1	1.68	Light mauve	Rather soft	
62-525	33	7.7	4	010	2.0	15.5	17.3	1.87	Salmon	Almost hard	Good appearance.
				06	5.1	9.6	11.1	2.08	Salmon red	Very hard	
				03	9.2	0.7	1.1	2.39	Dark red	Very hard	
62-526	28	4.9	4	010	+0.4	23.5	26.2	1.55	Mauve	Rather soft	Slight warping.
				06	+0.2	23.8	26.6	1.56	Cream-mauve	Rather soft	
				03	1.7	18.4	22.4	1.66	Cream-mauve	Mod. hard	
62-519	32	7.0	2	010	0.7	23.4	24.1	1.65	Light brown	Hard	Good appearance except for specking.
				06	1.2	20.4	21.2	1.71	Light salmon	Very hard	
				03	13.1	0.7	0.9	2.47	Dark red	Very hard	
62-518	37	8.9	2	010	1.5	23.0	24.3	1.69	Salmon-pink	Hard	Specking common.
				06	2.0	21.2	22.5	1.74	Dark red	Very hard	
				03	11.7	0.9	1.2	2.56	Dark red	Very hard	
62-520	22	6.5	5	010	0.2	12.2	13.2	1.93	Salmon	Almost hard	Good quality.
				06	2.0	8.7	10.7	2.02	Dark salmon	Hard	
				03	7.6	0.7	1.2	2.37	Dark red	Very hard	
62-619	23	5.6	5	010	0.0	12.7	14.1	1.88	Light salmon	Mod. hard	Good except for trace of scum.
				06	1.1	10.8	12.2	1.96	Salmon	Almost hard	
				03	6.4	2.3	3.0	2.30	Red	Very hard	
62-620	22	2.9	5	010	—	—	—	—	—	—	Mottled.
				06	0.7	13.8	15.7	1.85	Salmon	Almost hard	
				03	7.0	3.4	4.5	2.25	Red	Very hard	
62-624	20	2.9	4	010	+0.7	16.3	20.1	1.72	Sand	Rather soft	Sandy textured.
				06	+0.7	16.0	19.7	1.74	Pink-brown	Rather soft	
				03	—	—	—	—	—	—	
62-521	22	6.3	7	010	+0.5	23.8	27.5	2.59	Pink-buff	Rather soft	Rather chalky.
				06	+0.0	22.8	27.3	1.57	Cream	Rather soft	
				03	+0.9	21.3	27.3	1.58	Yellow-buff	Mod. hard	
62-522	20	5.8	—	010	0.5	27.3	30.1	1.56	Tan	Soft	Lime pops common.
				06	0.4	23.0	25.9	1.65	Cream-buff	Mod. hard	
				03	0.7	20.5	24.1	1.69	Buff	Almost hard	
62-624	27	8.0	5	010	1.4	20.7	22.3	1.69	Light salmon	Hard	Slightly blistered and cracked.
				06	1.4	19.8	21.3	1.70	Pink-buff	Hard	
				03	2.4	16.2	18.0	1.74	Buff	Very hard	
62-523	26	7.4	5	010	1.4	20.6	22.8	1.71	Salmon	Hard	Lime pops common.
				06	1.1	18.5	19.9	1.72	Light salmon	Hard	
				03	2.3	14.8	15.9	1.79	Salmon-buff	Very hard	

Table 28 continued: CERAMIC PROPERTIES — NORTHWESTERN ONTARIO CLAYS.

Sample	% Water of Plasticity	% Drying Shrinkage	PCE	Cone*	Fired Characteristics: % Firing Shrinkage**	% water Absorption: 24-hr. cold	% water Absorption: 5-hr. boiling	Specific Gravity	Colour	Hardness	Remarks
62-517	21	3.4	5-6	010	+1.7	33.4	36.8	1.38	Cream	Medium	Smooth textured and attractive.
				06	+2.9	34.6	38.8	1.33	Cream	Medium	
				03	+2.8	34.1	39.2	1.34	Buff-white	Medium	
62-516	23	4.3	4	010	4.7	32.0	34.9	1.40	Cream	Soft	White briquettes of excellent appearance.
				06	+2.6	33.3	36.2	1.38	Almost white	Medium	
				03	+1.7	33.6	37.1	1.39	Almost white	Medium	
63-650	23	8.0	4	010	+0.2	26.6	28.6	1.55	Tan-cream	Moderate	Attractive.
				06	+0.7	27.0	30.0	1.54	Cream-white	Moderate	
				03	0.7	24.9	28.1	1.60	Buff-white	Moderate	
63-651	23	4.3	5-6	010	+0.3	26.4	28.2	1.51	Cream-tan	Moderate	Attractive.
				06	+0.9	26.4	29.8	1.49	Grey-cream	Moderate	
				03	0.5	26.5	30.5	1.53	Cream-white	Moderate	
63-652	16	1.2	7	010	+1.2	30.6	35.4	1.42	Cream-grey	Rather soft	Rather chalky & soft
				06	+2.5	30.8	37.6	1.37	Cream-grey	Rather soft	
				03	+3.4	31.4	39.7	1.32	Cream-grey	Rather soft	
63-653	26	6.0	4	010	0.0	25.3	26.7	1.53	Light tan	Moderate	Attractive.
				06	0.0	26.2	29.3	1.51	Cream-white	Moderate	
				03	1.4	24.9	28.1	1.61	Buff-white	Moderate	
62-535	21	4.3	5-6	010	+1.2	26.5	28.3	1.51	Tan-buff	Rather soft	Attractive.
				06	+2.3	27.2	31.3	1.46	Cream	Rather soft	
				03	+0.9	24.3	29.1	1.54	Cream-white	Mod. hard	
62-536	21	3.4	5-6	010	+1.0	28.6	30.2	1.48	Tan-buff	Rather soft	Good quality.
				06	+2.4	28.3	33.1	1.44	Cream-white	Rather soft	
				03	+1.4	25.8	31.2	1.50	Cream-white	Rather soft	
62-531	33	7.3	3-4	010	0.9	24.9	25.4	1.66	Pink	Almost hard	Occasional yellow-white specking.
				06	1.4	22.7	23.8	1.69	Pink	Almost hard	
				03	12.81	1.4	1.6	2.57	Dark red	Very hard	
62-530	27	6.3	4	010	0.4	18.5	19.7	1.74	Mauve pink	Mod. hard	Fair.
				06	0.4	18.3	19.6	1.75	Mauve pink	Almost hard	
				03	9.1	5.2	5.9	2.23	Pink brown	Very hard	
62-532	42	10.0	4	010	1.8	25.7	27.0	1.63	Pink	Almost hard	Yellow-white specking common.
				06	2.6	24.8	26.1	1.65	Pink	Very hard	
				03	13.7	2.0	2.4	2.43	Dark red	Very hard	
62-533	37	8.3	1	010	1.8	23.1	24.7	1.67	Light salmon	Hard	Cracks common.
				06	2.2	21.2	22.5	1.73	Salmon	Hard	
				03	12.4	0.6	0.8	2.55	Dark red	Very hard	
62-534	39	10.0	3-4	010	1.7	23.6	24.5	1.68	Salmon-pink	Almost hard	Attractive but cracked.
				06	2.6	22.7	24.0	1.70	Salmon-pink	Almost hard	
				03	14.4	1.0	1.0	2.51	Dark red	Very hard	
62-529	27	5.7	4	010	0.4	20.9	23.0	1.64	Mauve	Soft	Smooth and uniform
				06	0.4	20.5	22.5	1.67	Light mauve	Rather soft	
				03	12.4	2.0	2.0	2.40	Brown	Very hard	

Table 28 continued: CERAMIC PROPERTIES — NORTHWESTERN ONTARIO CLAYS.

Sample	% Water of Plasticity	% Drying Shrinkage	PCE	Fired Characteristics								
				Cone*	% Firing Shrinkage**	% water Absorption		Specific Gravity	Colour	Hardness	Remarks
						24-hr. cold	5-hr. boiling				
66-662	28	6.6	6	010	0.3	14.9	16.0	1.89	Pale salmon	Fairly soft	Smooth textured and attractive.
				06	1.0	12.8	13.9	1.94	Salmon	Almost hard	
				03	3.2	1.0	1.7	2.40	Red brown	Steel hard	
63-648	29	6.9	2	010	0.2	19.0	19.7	1.74	Tan	Moderate	Slightly streaked.
				06	0.5	18.2	18.8	1.76	Salmon	Almost hard	
				03	7.7	4.0	5.1	2.24	Red	Very hard	
63-649	30	7.4	3-4	010	0.4	16.2	20.3	1.75	Salmon	Almost hard	Fairly attractive.
				06	1.1	14.9	15.8	1.88	Salmon-pink	Hard	
				03	7.2	0.9	1.4	2.36	Dark red	Very hard	

*Equivalent temperatures measured by optical pyrometer: cone 010 (1660°F), cone 06 (1840°F), cone 03 (1980°F).
**A plus (+) sign indicates expansion.

PIC RIVER (65)

A roadcut on the highway to Heron Bay (Highway 627), about 3 km (2 miles) from its junction with Highway 17, exposes a 4 m (14 feet) section of coarsely varved clay near the top of the west bank of the Pic River. Two samples were taken as follows.

Sample 62-517: The top 2 m (8 feet) of the bank consists of varved clay in couplets 5-7.5 cm (2-3 inches) thick, composed of light grey-brown silt and red-brown clay, decreasing in thickness towards the top. The lower 1 m (3 feet) is made up of several more massive beds of lighter coloured silt.

Sample 62-516: The lower 2 m (6 feet) of the bank is also coarsely varved, becoming progressively coarser towards the base. Individual couplets average 7.5 cm (3 inches) in thickness, of which about 20 percent is dark olive-grey plastic clay, the rest lighter coloured silt.

Varved clays and reworked stratified clays extend for many miles up the Pic River valley and along its tributaries. These are described by V.G. Milne (1967, p.29-32) who also submitted four sample for testing. His descriptions of these samples are reproduced as follows (Milne 1967, p.53-56).

> The valleys of the Pic River, Goodchild Creek, and Cirrus Creek, and almost all valleys of tributaries to the Pic River, are floored by great thicknesses of glaciolacustrine varved clays and bedded silty fluvial clays.... The varved clays are very smooth and clean and usually overlain by thin, bedded silty sands. The river clays are generally silty and probably consist of a homogeneous mixture of the silty sand and varved clay reworked by the river. Four samples were taken and submitted for ceramic tests to the Laboratory Branch, Ontario Department of Mines. Two samples of varved clay and two of silty river clay were submitted. The sample locations are shown on (ODM) Maps 2098 and 2099, and the sample descriptions... are given below.

Sample 63-650: Sample No.1 was taken from the west bank of Berin Creek.... The sample was taken over a 5 m (15 feet) section just above the creek-level and consisted of varved clay with 2.5 cm (1 inch) dark layers alternating with 1.2-2.5 cm (½-1 inch) light-grey layers.

Sample 63-651: Sample No.2 was taken from the west bank of the Pic River, about 240 m (800 feet) along the river, north from the Mile 16 (26 km) access road.... Under the top 6 m (20 feet) down to water-level, the banks are composed of varved clay.... The sample war taken over a 1.5 m (5 feet) section between 3 and 4.5 m (10 and 15 feet) above low-water mark.

Sample 63-652: Sample No.3 was taken from the west bank of the Pic River, about 1.6 km (1 mile) north from the mouth of Little Joe Creek.... The clay is non-varved. It is finely bedded with 0.3-0.6 cm (1/8-1/4 inch) layering, visible owing to faint colour differences between light-buff and grey. The clay is silty and silt layers are interbedded.

Sample 63-653: Sample No.4 was taken over a 4.5 m (15 feet) section on the east bank of the Pic River almost directly west of the south end of Roccian Lake.... From the waterline up to between 5-6 m (15-20 feet) the bank consists of blue-grey silty clay, finely bedded with laminae between 0.07-0.15 cm (1/32 and 1/16 inch).

NIPIGON (66)

Very coarsely varved silt and clay occurs as remnants against the Precambrian hills that surround Helen Lake, an enlargement of the Nipigon River. A section on the west shore adjacent to Highway 11 about 6 km (4 miles) north of its junction with Highway 17 is illustrated in Figure 36. Three samples were taken from an 8 m (25 feet) section upslope from the highway. The 5 m (15 feet) section between lake level and the road was unexposed.

Sample 62-536: The upper 3 m (10 feet) consists of 7.5 cm (3 inch) varves decreasing progressively to 2.5 cm (1 inch) at the top. The proportion of silty brown clay is about one-third, yellow silt predominating. The section is overlain by a foot of sandy clay loam containing a few stones.

Photo 10 – Coarsely varved silt north of Nipigon.

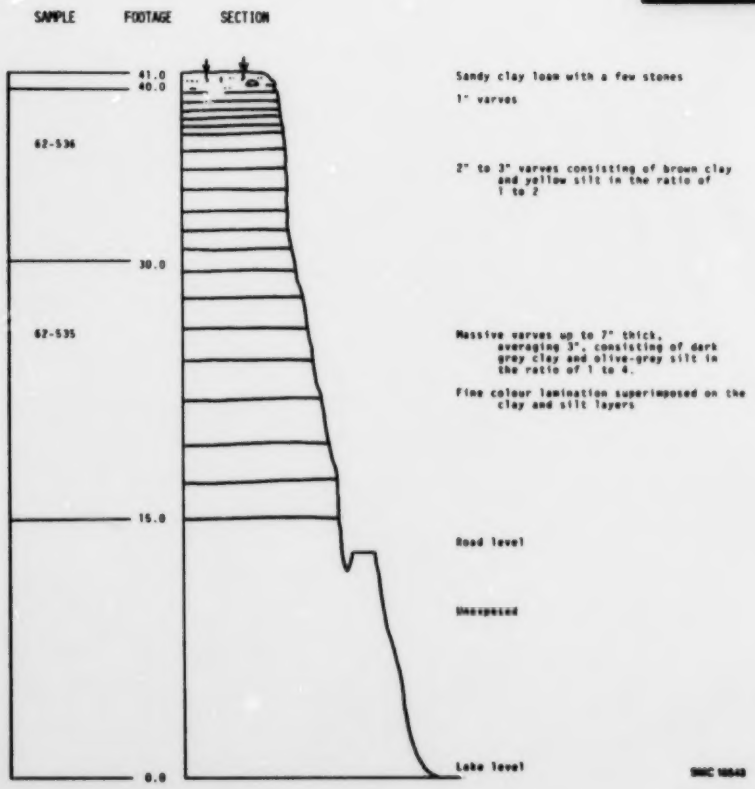

SAMPLE
FOOTAGE
SECTION
41.0
40.0
62-536
30.0
62-535
15.0
0.0
Sandy clay loam with a few stones
1" varves
2" to 3" varves consisting of brown clay and yellow silt in the ratio of 1 to 2
Massive varves up to 7" thick, averaging 3", consisting of dark grey clay and olive-grey silt in the ratio of 1 to 4.
Fine colour lamination superimposed on the clay and silt layers
Road level
Unexposed
Lake level

Figure 36 – Varved clay near Nipigon.

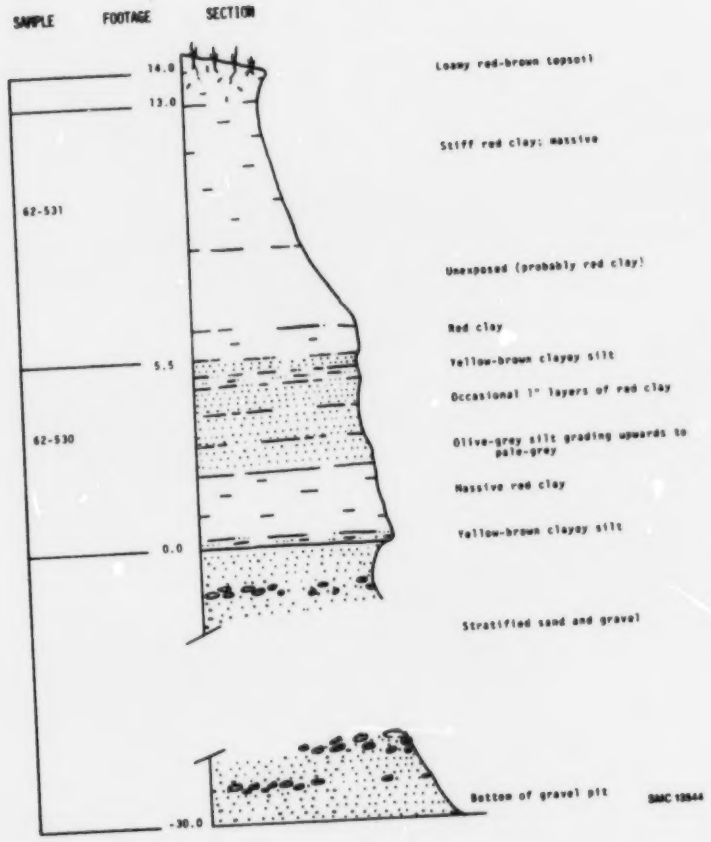


Figure 37 – Clay section near Dog Lake.

Sample 62-535: The underlying 5 m (15 feet) consists of very coarse varves (up to 18 cm; 7 inches, averaging 7.5 cm;3 inches) of olive-grey silt and minor dark grey silty clay. Silt to clay ratio is about 4 to 1, but clay content increases towards the top. A fine colour stratification is superimposed on the clay layers in some cases, due apparently to occasional influxes of silt during the winter months.

Sample 62-536A: A composite of the previous two samples.

DOG LAKE (67)

Thick deposits of red clay occur over a wide area south of Dog Lake, some 40 km (25 miles) northwest of Thunder Bay. The clay is exposed continuously for more than 0.4 km (¼ mile) along the Dog Lake Road at a point 1.6 km (1 mile) east of the Silver Falls power plant. Judging by the gradient of the road at this location, about 30 m (100 feet) of red clay must be present. The clay is both overlain and underlain by stratified sand and gravel. A 4 m (14 feet) section near the base of the clay unit is exposed at the top of a roadside gravel pit. The section is illustrated in Figure 37. Two samples were taken as follows.

Sample 62-531: The upper 2 m (7½ feet) consists of massive, smooth, stiff red clay without stones, roots, or laminations. An overlying foot of loamy red-brown topsoil was not sampled.

Sample 62-530: The lower 1.7 m (5½ feet) of the section consists of a 0.6 m (2 feet) bed of massive red clay overlain by 0.9 m (3 feet) of pale grey and olive-grey silt with occasional thin layers of red clay.

FINMARK (68)

Red clay is exposed near Finmark on the Canadian Pacific Railway, about 40 km (25 miles) northwest of Thunder Bay, and south of Conmee near the junction of Highways 17 and 17A. Two samples were taken near Finmark and one near Conmee as follows.

Sample 62-532: A bulk sample of red clay from the roadbank 90 m (100 yards) north of Finmark Station contains occasional limy pebbles or concretions.

Sample 62-533: A sample of stiff red clay from a 2.5 m (8 feet) bank along the road 0.8 km (½ mile) south of Finmark.

Sample 62-534: A sample of stiff red clay was taken from a 6 m (20 feet) bank on the south side of Highway 17A 0.4 km (¼ mile) east of its junction with Highway 17.

PINE BAY (69)

Stratified red clay overlies unstratified beds of brown clay and olive-grey silt in the Pine River valley and in the vicinity of Pine Bay. These clays were sampled 2 km (1 mile) or so east of Highway 61, about 20 km (12 miles) northeast of Pigeon River. Four samples were taken from the upper 3 m (11 feet) of an 8 m (26 feet) bank of the Pine River; the lower part of the bank was unexposed due to sloughing.

Sample 62-529: The top 1 m (4 feet) of the bank consists of smooth red-brown clay variably stratified with veneers of grey silty clay. The section is stoneless, but contains a few roots. Stratified clay grades downwards into massive clay as in the following sample.

Sample 62-528: One metre (4 feet) of massive, smooth, plastic grey-brown clay with occasional patches of red clay and grey silt. The clay has good workability and is stoneless.

Sample 62-527: The lower 1 m (3 feet) of the exposed section of the bank is uniform, massive, olive-grey silt of low plasticity.

Sample 62-529A: A composite of the previous three samples.

Several samples were also taken along Memory Road, midway between Highway 61 and Pine Bay, using a posthole auger.

Sample 62-525: A 0.6 m (2 feet) section of massive red plastic clay having a low grit content.

Sample 62-526: A 0.6 m (2 feet) section of very loamy, stoneless, massive, brown to slightly red, smooth plastic clay, from a location apparently stratigraphically lower than the previous sample and located 0.4 km (¼ mile) west of it.

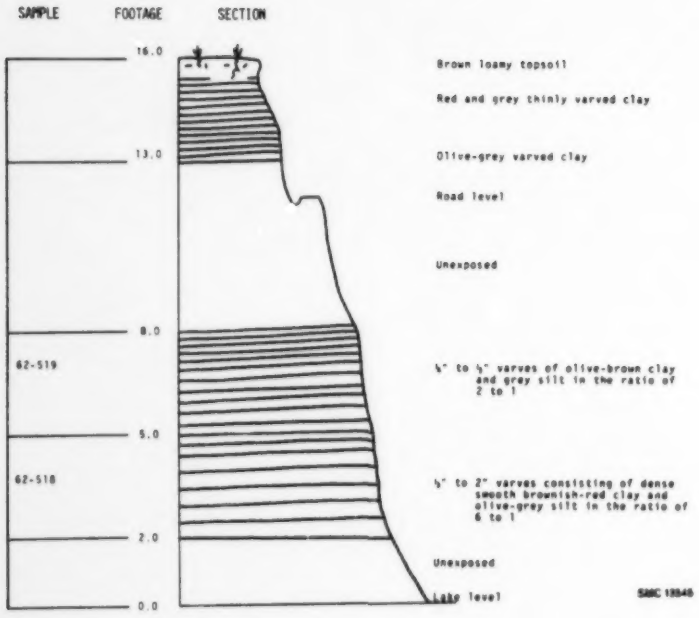


Figure 38 – Varved clay at Wabigoon Lake.

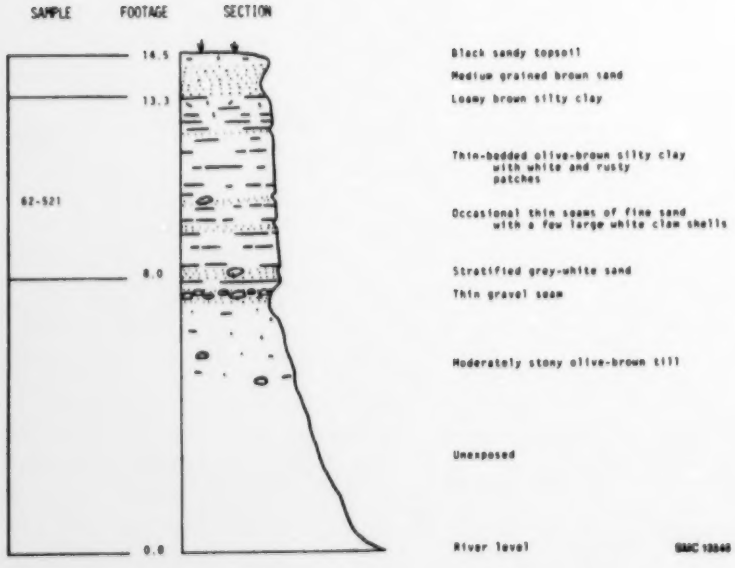


Figure 39 – Rainy River clay.

WABIGOON LAKE (70)

Varved clays in the Dryden area are described by Collins (1909, p.50) and Satterly (1943, p.44). A section on the shore of Contact Bay at the southwest end of Wabigoon Lake, 26 km (16 miles) south of Dryden, was sampled as follows. The section is illustrated in Figure 38.

Sample 62-519: The top 1 m (3 feet) of a 2.5 m (8 feet) shore bank is thinly (less than 1.2 cm; ½ inch) varved clay composed of couplets of olive-brown clay and olive-grey silt.

Sample 62-518: Only the upper 1 m (3 feet) of the underlying 1.5 m (5 feet) bank to lake level was accessible for sampling. This is a much coarser varved sequence, consisting of relatively thick (1.2-5 cm; ½-2 inch) layers of smooth, dense, tough brown-red clay alternating with 0.6 cm (¼ inch) laminae of olive-grey silt.

KENORA (71)

Clay is largely restricted to shallow depressions between rock outcrops in the Kenora area. An occurrence near Laclu, 14 km (9 miles) west of Kenora, was sampled by the roadside at a point 180 m (200 yards) south of the narrows bridge, about 2 km (1 mile) north of the railway.

Sample 62-520: A poorly exposed section consists of 0.9-1.2 m (3 or 4 feet) of loamy and mottled brown and olive-grey clay overlying sand and fine gravel. The clay is somewhat gritty, but plastic, and contains a few pebbles and numerous fine roots. Stratification is not obvious. The section is topped by several inches of grey silt and topsoil.

Other clay samples from the Kenora area were taken by J.C. Davies in the northeast outskirts of town, and at Norman on the shore of Lake-of-the-Woods several miles west of Kenora.

Sample 62-619: The upper 0.9 m (3 feet) of varved clay underlying 1.2 m (4 feet) of sand.

Sample 62-620: A small bulk sample of grey silty clay.

REDDITT (72)

J.C. Davies submitted a sample collected in the vicinity of Redditt, a community located on the Canadian National railway line some 32 km (20 miles) north of Kenora.

Sample 63-624: A 1 m (3 feet) section of silty grey clay.

RAINY RIVER (73)

Stratified silty clay and sand overlie till in the river bank 3 km (2 miles) west of Rainy River. A section sampled at a public picnic area 1.6 km (1 mile) west of the railway and International bridges is described as follows and illustrated in Figure 39.

Sample 62-521: A 1.5 m (5 feet) section of stratified clay and sand is exposed near the top of the 4 m (14 feet) bank. Till and lenses of gravel occupy the lower 2 m (8 feet). The 1.5 m (5 feet) sampled section consists of olive-brown silty calcareous clay, drying to buff and mottled with white and rusty patches, interlayered with seams of fine sand. Sand seams contain occasional white clam shells, and rarely pebbles. Roots are fairly common throughout.

EMO (74)

Much of the terrain between Rainy River and Emo is a flat clay plain made more conspicuous by the numerous small yellow-white subangular limestone pebbles on its surface. A roadside bank was sampled on Highway 602 on the south side of Emo about 300 m (1,000 feet) north of the railway.

Sample 62-522: Only the upper 1 m (3 feet) of a 3 m (10 feet) clay section was accessible immediately beneath a sandy loam topsoil. The section consists of alternating layers of yellow-brown silty clay, 2.5-5 cm (1-2

inches thick, and smooth grey clay up to 0.6 cm (¼ inch) thick. Cream weathered limestone pebbles to 0.6 cm (¼ inch) are rather common.

FORT FRANCES (75)

Five metres (15 feet) of till, not excessively stony, is exposed at the top of a sand and gravel pit located on the south side of Highway 11 on the west side of Fort Frances. A 12-15 m (40-50 feet) thickness of stratified sand and gravel is exposed beneath the till. Two samples of the till were taken as follows.

Sample 62-524: The top 1.5 m (5 feet) consists of a massive dark olive-grey till, mottled with blue and rusty brown, containing a low to moderate number of limestone particles about 0.3 cm (1/8 inch) in size.

Sample 62-523: The underlying 1.5 m (5 feet) is similar tough, blocky till, but containing more numerous stones averaging 0.6 cm (¼ inch) with a maximum of 2.5 cm (1 inch). Stoniness increases with depth.

GLENORCHY (76)

A sample submitted by Mr. Basil Riordon of Fort Frances was said to have been obtained near Highway 11, 80 km (50 miles) east of Fort Frances.

Sample 66-662: A small bulk sample of buff-coloured clay.

RED LAKE (77)

S.A. Ferguson submitted two samples for testing, obtained from the Red Lake area.

Sample 63-648: A small bulk sample of smooth brown clay.

Sample 63-649: A small bulk sample of smooth brown clay.

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